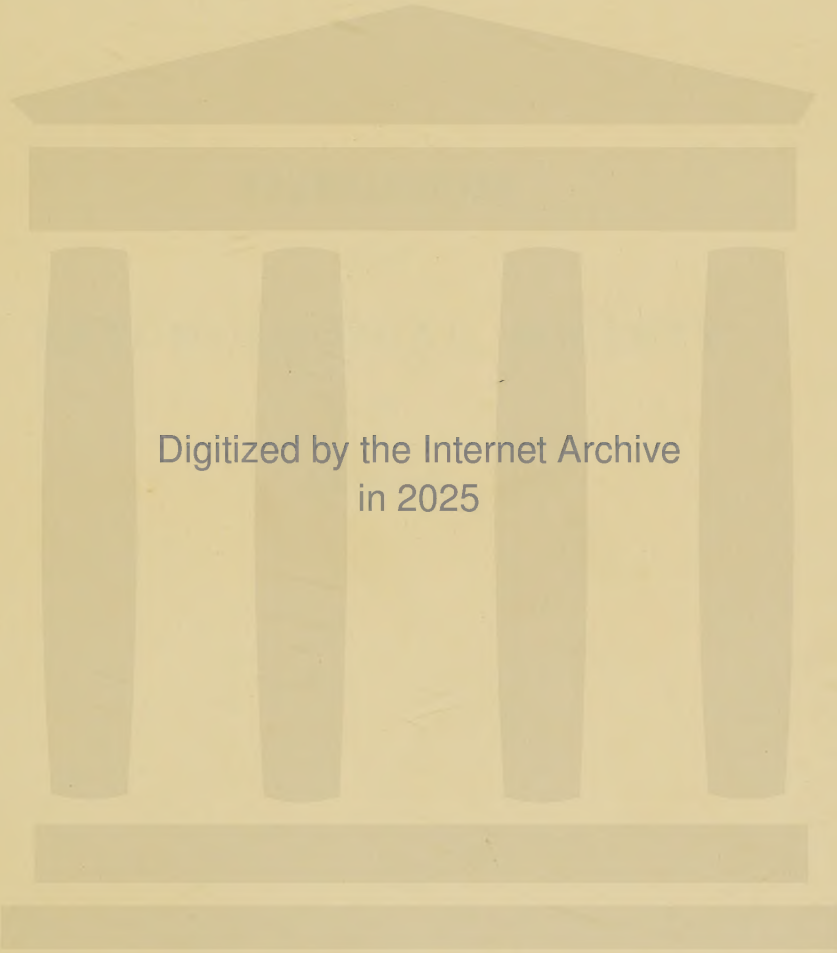




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TRANSACTIONS
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1930.

THE CARABIDAE OF THE THIRD MOUNT EVEREST EXPEDITION,
1924

By H. E. ANDREWES.

[Read December 4th, 1929.]

WITH ONE MAP.

ON the First Mount Everest Expedition (1921) no CARABIDAE were collected, and the Second Expedition (1922) secured comparatively few examples, though the five species, of which specimens were captured by Dr. T. G. Longstaff, all proved to be undescribed. In the Third Expedition (1924) entomological science was more fortunate, for Major R. W. G. Hingston, quite apart from his medical attainments, proved a most indefatigable collector, and his notes in the *Fight for Everest* show what a keen naturalist he is. Of the 10,000 specimens of animals collected, over 1450 belong to the CARABIDAE, a family which comprises a large proportion of the insects met with at high altitudes. I have thought it best to deal in this paper with the whole of the specimens taken, whether found in the better known and generally lower regions of Sikkim or in the lofty wilds of Tibet, and enumerate below 105 species and varieties. More than half of these, namely 54, prove to be new; of these four have already been described elsewhere, and descriptions of the remaining 50 appear here, together with those of four new genera. All the five species discovered in 1922 by Dr. Longstaff were met with again in 1924.

While many of these insects are peculiar either to Sikkim or Tibet, some were found on both sides of the frontier; further, of the total of 105 species as many as 21 occur also in the Western Himalayas, while 14 have a wider range still, extending to Burma, Indo-China, in two instances to Japan, and in another one as far as Australia. The genera are almost entirely palaearctic, but in regard to species, the connexion with the Central Asian fauna is very slight, though there is some evidence of it in the presence of a species of *Taphoxenus* in Southern Tibet, and one species, *Bembidion pictum*, Fald., is also found both in Turkestan and in Mongolia. Yet one further species, *Anchomenus quadri-*

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punctatus, de Geer, of which many specimens were captured in Tibet, has a very wide though unequal distribution not only in the palaearctic, but also in the nearctic region. Little is known of the biology of these insects at great altitudes, but the conditions are severe, and Major Hingston writes, "We sometimes exposed numbers of dead insects, regular cemeteries underneath stones." Another point noted is that "the ground beetles seemed habitually to hibernate in pairs."

Accompanying this paper will be found a map, showing the route followed by Major Hingston and all his camping places. This gives a bird's-eye view of nearly all the localities where the collection was formed, and also obviates the necessity for a constant repetition of dates and altitudes. The map was prepared by my nephew, Mr. J. C. Hamer, from sketches supplied by Major Hingston, and, in view of the varied methods in vogue for transliterating Sikkimese and Tibetan place-names, an attempt has been made, with the kind help of Mr. F. Allen at the offices of the Royal Geographical Society, to standardise the spelling as far as possible. The only collecting grounds not shown on the map are one valley and three passes, situated as follows:—(i) Chumbi Valley, 11,000 feet, extending from the Jelep La to Gautsa, (ii) Dinka La, 16,000 feet, between Tinki Dzong and Chusar, (iii) Pang La, 17,000 feet, between Pangle and Tashidzom, (iv) Phuse La, 16,000 feet, between Kyetrak and Tasam.

Below is a list of the species, followed by descriptions of the new ones and of the new genera, and a key to the Tibetan species of *Bembidion*. With one exception (*Nirmala odelli*), the type specimens of all the new species are in the British Museum.

1. *Carabus everesti*, Andr., 1929, Faun. Brit. Ind., Carab. 1 : 76.

TIBET : Rongshar Valley, 4 ex. Very nearly allied to the Nepalese *C. wallichii*, Hope, but having two or three lateral setae on the front half of the prothorax and equal elytral intervals.

2. *Carabus sanchari*, Andr., 1921, Ann. Mag. Nat. Hist. (9), 7 : 407.

TIBET : Phari, 1 ex. All the hitherto known examples appear to have been taken either at Natang, in Sikkim, or on the Tibetan side of the Jelep La.

3. *Nebria superna*, Andr., 1923, Ann. Mag. Nat. Hist. (9), 11 : 273.

TIBET : Rongbuk, 10 ex. Found at the same place by Dr. Longstaff on the 1922 Expedition, and not known from any other locality.

4. *Nebria pharina*, Andr., 1929, Faun. Brit. Ind., Carab. 1 : 132.

TIBET : Phari, 4 ex. Quite unlike any other Himalayan species, but nearly allied to *N. roborowskii*, Sem., from Western China.

5. *Leistus indus*, Tchitch., 1903, Rev. Russ. Ent. 3 : 109.

SIKKIM : Darjeeling, 2 ex. Specimens have been taken in other parts of Sikkim, but not, so far as I am aware, in any other district.

6. *Paropisthius indicus*, Chaud., 1863, Ann. Soc. Ent. Fr. 1863 : 449.

SIKKIM : Natang and Karponang. TIBET : Jelep La, Chumbi Valley, Gautsa, and Kampa Dzong, numerous examples. A handsome insect, common

in Sikkim, and apparently also in Tibet. In appearance it is somewhat like a large *Elaphrus*, but actually with only one near ally, found in the western states of North America.

7. **Brososoma ribbei**, Putz., 1877, Stett. Ent. Zeit. **38** : 100.

SIKKIM : Karponang, 1 ex. Found only in Sikkim.

8. **Asaphidion indicum**, Chaud., 1850, Bull. Mosc. **1850**, ii : 189 (note).

SIKKIM : Darjeeling, 1 ex. Eight species of this genus have already been described from the Himalayas, and probably many others remain to be discovered. *A. indicum* is the commonest of them and is found at elevations of from 5000 to 8000 feet from the Simla Hills to Sikkim.

9. **Bembidion livens**, sp. nov. (see p. 11).

10. **Bembidion hingstoni**, sp. nov. (see p. 11).

11. **Bembidion nivicola**, Andr., 1923, Ann. Mag. Nat. Hist. (9), **11** : 275.

TIBET : Rongbuk and Tashidzom, many ex. The species was described from two examples discovered by Dr. Longstaff at the Rongbuk base camp.

12. **Bembidion elatum**, sp. nov. (see p. 12).

13. **Bembidion cymindulum**, sp. nov. (see p. 13).

14. **Bembidion exornatum**, sp. nov. (see p. 13).

15. **Bembidion pictum**, Fald., 1835, Mém. Acad. St. Petersb. **2** : 357.

TIBET : Tuna, Kampa Dzong, Lingga, Tinki Dzong, Kyishong, Shekar, Pangle, Tashidzom, Chodzong, many ex. A very variable and apparently common species, which ranges from Mongolia, through Turkestan and Tibet, as far as Kashmir.

16. **Bembidion radians**, Andr., 1922, Ent. Month. Mag. **58** : 177.

SIKKIM : Darjeeling, Phadamchen, Natang, and Tangu. TIBET : Jelep La, Yatang, Gautsa, Phari, and Rongshar Valley, numerous ex. A common insect throughout the Himalayas.

17. **Bembidion infans**, sp. nov. (see p. 14).

18. **Tachys haliploides**, Bates, var. **nigrinus**, Andr., 1925, Ann. Mus. Civ. Gen. **51** : 479.

SIKKIM : Darjeeling, 10 ex. Found also in Kumaon and Assam.

19. **Trechus indicus**, Putz., 1870, Stett. Ent. Zeit. **31** : 175.

SIKKIM : Rangli, 1 ex. The species of this genus are not common insects in India, but this is the commonest and is met with from the Simla Hills to Sikkim.

20. **Trechus imaicus**, Jeann., 1923, Ann. Mag. Nat. Hist. (9), **12** : 421, f. 13.

SIKKIM : Karponang, 2 ex. The type and only other known specimen was taken by Mr. H. Stevens at Tonglu, 10,000 feet, on the Sikkim-Nepalese frontier.

21. **Trechus thibetanus**, Jeann., 1928, Ann. Mag. Nat. Hist. (10), 1 : 284, f. 1.

SIKKIM : Tangu. TIBET : Chumbi Valley, Gautsa, Tuna, Pangle, Pang La, Tashidzom, Lamna La, Phuse La, and Tasam, many ex. This species, described by Dr. Jeannel from the material brought back by the Expedition, appears to be a common one in Tibet.

22. **Trechus hingstoni**, Jeann., 1928, Ann. Mag. Nat. Hist. (10), 1 : 288, f. 2.

SIKKIM : Natang, 12 ex.

23. **Diplous nortoni**, sp. nov. (see p. 14).

24. **Zabrus malloryi**, sp. nov. (see p. 15).

25. **Chydaeus bedeli**, Tchitch., 1897, Abeille 29 : 66.

SIKKIM : Darjeeling, Karponang, and Tangu. TIBET : Yatang, Chumbi Valley, and Rongshar Valley, many ex. A common insect on the southern slopes of the Himalayas, and found also in Western China.

26. **Chydaeus obscurus**, Chaud., 1854, Bull. Mosc. 1854, i : 344.

SIKKIM : Darjeeling, Phadamchen, Karponang, Lachen, Tangu. TIBET : Yatang, Chumbi Valley, and Rongshar Valley, many ex. Quite as common in the Himalayas as the previous species, and brought back in very large numbers by the Expedition. Only one other species of the genus has been described, viz. *C. bakeri*, Andr., from the Philippine Is.

27. **Dioryche torta**, Macl., 1825, Ann. Jav. : 21.

SIKKIM : Rangli, 1 ex. Very common all through South-East Asia.

28. **Ophonus indicus**, Bates, 1891, Bull. (C.R.) Soc. Ent. Belg. 1891 : cccxxxii.

SIKKIM : Darjeeling and Singhik, 3 ex. Another very common Himalayan insect, with near allies in Indo-China and China.

29. **Harpalus karennius**, Bates, 1892, Ann. Mus. Civ. Gen. 32 : 341.

SIKKIM : Pedong, 1 ex. In addition to Sikkim this species has been met with in Assam, Burma, and Indo-China. Bates has already pointed out that owing to the peculiar form of the frontal foveae the species can hardly remain in the genus *Harpalus*, but I leave it for the present where he placed it pending a general revision of the Indian Harpalini.

30. **Harpalus tibeticus**, sp. nov. (see p. 16).

31. **Harpalus indicola**, Bates, 1878, Proc. Zool. Soc. 1878 : 714.

SIKKIM : Darjeeling and Phadamchen. TIBET : Yatang and Chumbi Valley. Numerous specimens. Another common species ranging from Kashmir to Sikkim.

32. **Harpalus lepcha**, sp. nov. (see p. 16).

33. **Harpalus irvinei**, sp. nov. (see p. 17).

34. **Harpalus metarsius**, sp. nov. (see p. 17).

35. **Harpaliscus birmanicus**, Bates, 1892, Ann. Mus. Civ. Gen. **32** : 341.

SIKKIM : Kalimpong, 1 ex. Found also in Assam, and very common in Burma and Indo-China. It is replaced in Southern India by *H. punctulatus*, Andr., the only other described species in the genus.

36. **Coleolissus noeli**, sp. nov. (see p. 18).

37. **Trichotichnus aquilo**, sp. nov. (see p. 18).

38. **Trichotichnus hingstoni**, sp. nov. (see p. 19).

39. **Trichotichnus emarginatus**, sp. nov. (see p. 20).

40. **Trichotichnus glabellus**, sp. nov. (see p. 20).

41. **Stenolophus smaragdulus**, F., Suppl. Ent. Syst. 1798 : 60.

SIKKIM : Pedong and Phadamchen, 4 ex. Probably the commonest, as it is one of the most variable species in South-East Asia.

42. **Acupalpus sikkimensis**, sp. nov. (see p. 20).

PSYCHRISTUS, gen. nov. (see p. 21).

43. **Psychristus liparops**, sp. nov. (see p. 21).

44. **Psychristus discretus**, sp. nov. (see p. 22).

45. **Amara** (in sp.) **darjelingensis**, Putz., 1877, Stett. Ent. Zeit. **38** : 102.

SIKKIM : Darjeeling and Tangu, 6 ex. TIBET : Yatang, Chumbi Valley, and Rongshar Valley, 9 ex. One of the most widely spread species of the genus on the Southern Himalayan slopes; it has been taken up to 9300 feet in the Punjab, and occurs also in the United Provinces and Assam.

46. **Amara** (in sp.) **algida**, sp. nov. (see p. 22).

47. **Amara** (in sp.) **gelida**, sp. nov. (see p. 23).

48. **Amara** (in sp.) **somervelli**, sp. nov. (see p. 23).

49. **Amara** (*Celia*) **faucium**, sp. nov. (see p. 24).

50. **Amara** (*Leiocnemis*) **elegantula**, Tchitch., 1899, Hor. Soc. Ent. Ross. **32** : 659.

SIKKIM : Natang, 4 ex. TIBET : Jelep La, Gautsa, and Chodzong, 8 ex. The original specimens were said to come from Darjeeling, but, as the altitude is given as 12,000 feet, the actual collecting ground must have been some more elevated region, no doubt also in Sikkim. I have also seen examples taken by Mr. H. Stevens at Lachung in Northern Sikkim, and a single specimen, without

locality label and now in the Madrid Museum, which I believe to have come from Eastern Sikkim.

51. *Amara* (*Leiocnemis*) *sikkimensis*, sp. nov. (see p. 24).

52. *Amara* (*Bradytus*) *batesi*, Csiki, 1929, Col. Cat. **104**, Carab.: 454 (= *compacta*, Bates (nec Lec.), Proc. Zool. Soc. **1878** : 717).

SIKKIM: Darjeeling, 4 ex. TIBET: Yatang, Gautsa, Chumbi Valley, Rongshar Valley, Tropde, many ex. Another common species, ranging westwards as far as Kashmir, but apparently not extending eastwards beyond Sikkim. It appears to be particularly plentiful in the Simla Hills.

53. *Amara* (*Bradytus*) *mitis*, sp. nov. (see p. 25).

54. *Amara* (*Leiromorpha*) *hypsula*, Andr., 1923, Ann. Mag. Nat. Hist. (9), **11** : 277.

TIBET: Phari, Tuna, Kampa Dzong, Tingri, Pangle, Rongbuk, Lamna La, Kyetrak, Rongshar Valley, many ex. By far the largest number of examples came from Rongbuk, where also all the specimens taken by Dr. Longstaff in 1922 were found. A re-description of this species will be found among the descriptions of the new ones.

55. *Amara* (*Leiromorpha*) *charis*, sp. nov. (see p. 26).

56. *Amara* (*Leiromorpha*) *sublimis*, sp. nov. (see p. 26).

57. *Amara* (*Leiromorpha*) *pinguis*, sp. nov. (see p. 27).

58. *Amara* (*Cumeres*) *brucei*, Andr., 1923, Ann. Mag. Nat. Hist. (9), **11** : 276.

TIBET: Rongbuk, Lamna La, Kyetrak, Tasam, Rongshar Valley, many ex. The great bulk of the specimens taken by Major Hingston, like those formerly collected by Dr. Longstaff, came from Rongbuk. The species was described as a *Leiromorpha*, but, as I have pointed out elsewhere, it is better placed in the subgenus *Cumeres*. In 1926 (Ent. Mon. Mag. **62** : 76) I described, under the name of *A. (Cumeres) thalia*, a species taken by Mr. H. G. Champion on the Supi River in another part of Tibet. On a re-examination of the material I find I cannot satisfactorily distinguish this from *A. brucei*, and am therefore treating it as a synonym.

59. *Amara* (*Niphobles*) *splendens*, Andr., 1926, Ent. Mon. Mag. **62** : 75.

TIBET: Chodzong, 1 ex. The original specimens were taken by Mr. H. G. Champion on the Kumaon-Tibetan frontier at altitudes ranging from 11,500 to 15,750 feet. The subgenus is remarkable for having in the ♂ the mesotibiae bispinose and the metatibiae furnished with a fringe of hairs.

60. *Amara* *histrio*, sp. nov. (see p. 28).

61. *Amara* *alecto*, sp. nov. (see p. 28).

62. *Pterostichus* (*Bothriopterus*) *aeneocupreus*, Fairm., 1887, Ann. Soc. Ent. Belg. **31** : 95.

TIBET : Jelep La, Yatang, Chumbi Valley, Gautsa, Tasam, Tropde, Rongshar Valley, many ex. Widely spread in Western and South-Western China, but not yet met with in India or Burma.

63. **Pterostichus exochus**, sp. nov. (see p. 29).

NIRMALA, gen. nov. (see p. 30).

64. **Nirmala odelli**, sp. nov. (see p. 30).

65. **Abacetus quadrinotatus**, Chaud., 1869, Bull. Mosc. **1869**, i : 388.

SIKKIM : Gangtok, 1 ex. Common on the southern slopes of the Himalayas from the Punjab to Assam.

LEPCHA, gen. nov. (see p. 31).

66. **Lepcha jelepa**, sp. nov. (see p. 32).

67. **Lepcha lampira**, sp. nov. (see p. 32).

68. **Taphoxenus brucei**, sp. nov. (see p. 33).

69. **Calathus kollari**, Putz., 1873, Ann. Soc. Ent. Belg. **16** : 72.

SIKKIM : Darjeeling, 1 ex. One of the commonest of Himalayan insects, with a habitat which includes Baluchistan on the west, Tibet on the north, and Sikkim on the east. I have no record from Assam.

70. **Megalonychus birmanicus**, Bates, 1892, Ann. Mus. Civ. Gen. **32** : 369.

SIKKIM : Kalimpong, 1 ex. Though not common, this species occupies a wide area of dispersion, including the United Provinces, Bihar, Bengal, Sikkim, Assam, Burma, and Laos.

71. **Dieranoneus femoralis**, Chaud., 1850, Bull. Mosc. **1850**, i : 393.

SIKKIM : Gangtok, 1 ex. Found throughout the Himalayas, in Northern India, Northern Burma, Indo-China, and Japan. I have seen no authentic specimens from Central or Southern India, or from China. Bates mentions Java as a locality, but this wants confirmation.

72. **Colpodes olivius**, Bates, 1873, Trans. Ent. Soc. Lond. **1873** : 330.

SIKKIM : Darjeeling, 2 ex. I have seen examples of this species from the Nilgiri Hills, Bengal, Assam, Burma, Tonkin, and Southern China.

73. **Colpodes impunctatus**, Andr., 1923, Ann. Mag. Nat. Hist. (9), **12** : 685.

SIKKIM : Darjeeling, 1 ex. The type, taken by Mr. H. Stevens, came from Tonglu, 10,000 feet; a second specimen from Darjeeling is in the Indian Museum.

74. **Colpodes vikara**, Andr., 1923, Ann. Mag. Nat. Hist. (9), **12** : 684.

SIKKIM : Karponang, 1 ex. TIBET : Tropde, 1 ex. Like that of the previous species, the type of this one was captured by Mr. Stevens at Tonglu. I have also seen two specimens collected by Mr. H. G. Champion in the Pindar

Valley, Almora, 8000-11,000 feet, and one found by Mr. F. Kingdon Ward at 9500 feet in the Seinghku Valley, Burma.

75. *Colpodes imitator*, sp. nov. (see p. 34).

76. *Colpodes shebbearei*, sp. nov. (see p. 34).

77. *Anchomenus praetor*, sp. nov. (see p. 35).

78. *Anchomenus venator*, sp. nov. (see p. 36).

79. *Anchomenus ambulator*, sp. nov. (see p. 36).

80. *Anchomenus cursor*, sp. nov. (see p. 37).

81. *Anchomenus praedator*, sp. nov. (see p. 38).

82. *Anchomenus fur*, sp. nov. (see p. 39).

83. *Anchomenus relucens*, Andr., 1923, Ann. Mag. Nat. Hist. (9), 12 : 681.

SIKKIM : Phadamchen, Karponang, Lachen, and Tangu. TIBET : Yatang. Numerous examples. Common in Sikkim. I have also seen specimens from the Simla Hills. Two examples in the British Museum are labelled Singapore and Java respectively.

84. *Anchomenus ladakensis*, Bates, 1878, Proc. Zool. Soc. 1878 : 718.

TIBET : Shekar, 4 ex. The typical specimens came from the Pangong Valley and the Pamir, and I have seen others from Ladak. On the Tibet Expedition of 1904 Mr. H. J. Walton met with an example at Gyangtse, 13,000 feet, and in 1913 Major Hingston took two specimens at Taghdumbash in the Pamir.

85. *Anchomenus lissopterus*, Chaud., 1854, Bull. Mosc. 1854, i : 136.

SIKKIM : Darjeeling, Phadamchen, and Lachen. TIBET : Yatang, Chumbi Valley, Tropde, and Rongshar Valley, many ex. Common throughout the Himalayan tract.

86. *Anchomenus quadripunctatus*, de Geer, 1774, Mém. Ins. 4 : 102.

TIBET : Kyishong, Pangle, Pang La, Tashidzom, Chodzong, Tasam, and Tropde. A large number of examples was taken, especially at Pangle. The species is sparsely distributed throughout the northern districts of the palaearctic and nearctic regions, and in mountainous regions further south. In India it has been met with in the Simla Hills and in Kumaon.

APARUPA, gen. nov. (see p. 39).

87. *Aparupa exophthalmica*, sp. nov. (see p. 40).

88. *Aparupa villosa*, sp. nov. (see p. 41).

89. *Aparupa beethami*, sp. nov. (see p. 41).

90. **Desera nepalensis**, Hope, 1831, in Gray, Zool. Misc. : 21.

SIKKIM : Phadamchen and Gangtok, 3 ex.

91. **Brachinus hazardi**, sp. nov. (see p. 42).

92. **Aephnidius adelioides**, MacL., 1825, Ann. Jav. : 23, t. 1. f. 7.

SIKKIM : Rangli, 1 ex. The range of this common species covers the whole of South-East Asia, extending to Japan in the East, and to New Guinea and Australia in the South.

93. **Tetragonoderus arcuatus**, Dej., var. **cardoni**, Bates, 1891, Bull. (C.R.) Soc. Ent. Belg. 1891 : cccxxxviii.

SIKKIM : Pedong, 1 ex. The species is found in Egypt, Irak, India, Burma, and Indo-China. The specimens from Mogador mentioned by Bates (1892, Ann. Mus. Civ. Gen. 32 : 415) should no doubt be referred to *T. extremus*, Bedel. Bates' *T. cardoni* is a highly sericeous form of the species found in North-East India.

94. **Taridius stevensi**, Andr., 1923, Ann. Mag. Nat. Hist. (9), 12 : 689.

SIKKIM : Kalimpong, 1 ex. Mr. H. Stevens collected many examples in Sikkim, and I have seen one specimen from Tanakpur in the United Provinces taken by Mr. H. G. Champion.

95. **Cymindis longstaffi**, Andr., 1923, Ann. Mag. Nat. Hist. (9), 11 : 277.

TIBET : Phari, Tuna, Kampa Dzong, Tinki Dzong, Dinka La, Chusar, and Rongbuk, numerous ex. Dr. Longstaff's specimens were all found at Rongbuk, and the species is only known from the material collected by the two Expeditions.

96. **Cymindis hingstoni**, sp. nov. (see p. 42).

97. **Metabletus impar**, sp. nov. (see p. 43).

98. **Metabletus cymindulus**, Bates, 1892, Ann. Mus. Civ. Gen. 32 : 418.

SIKKIM : Kalimpong, 5 ex. Fairly common in Northern India and not altogether confined to the mountains. The species occurs also in Yunnan.

99. **Dromius indicus**, Andr., 1923, Ann. Mag. Nat. Hist. (9), 12 : 686.

SIKKIM : Singhik, 2 ex. Known also from Kumaon and Buxar Duars.

100. **Dromius adoxus**, Andr., 1923, Ann. Mag. Nat. Hist. (9), 12 : 687.

SIKKIM : Darjeeling, 8 ex. Found in the Punjab, United Provinces, and Sikkim, but not confined to the mountains, as I have recently seen examples taken at Lyallpur.

101. **Risophilus luridus**, Schm.-Goeb., 1846, Faun. Col. Birm. : 35.

SIKKIM : Gangtok, 3 ex. This species has a fairly wide range, for I have seen examples from Sikkim, Assam, Burma, Laos, Tonkin, and Formosa.

102. **Risophilus suturalis**, Schm.-Goeb., 1846, Faun. Col. Birm. : 34.

SIKKIM: Dikchu, Singhik, and Tsuntang, numerous ex. The only other specimens which I have seen came from Burma.

103. *Stephana princeps*, Chaud., 1852, Bull. Mosc. 1852, i: 42.

The locality here is in doubt, but the specimen probably came from Sikkim. A scarce species, but found occasionally on the Southern Himalayan slopes.

104. *Lebia aglaia*, sp. nov. (see p. 44).

105. *Lebidia bioculata*, Moraw., var. *himalayica*, Andr., 1924, Ann. Mag. Nat. Hist. (9), 14: 243.

SIKKIM: Singhik, 3 ex. Found also in Kumaon and Burma. A small genus, of which the species and varieties are distributed through Japan, China, North India, Burma, Sumbawa, and Allor.

KEY TO THE TIBETAN SPECIES OF *BEMBIDION*.

- 1 (14). Elytra with a distinct microsculpture; upper surface blue, green, bronze, or aeneous, with or without pale markings.
- 2 (3). Upper surface blue, or greenish blue; head with a few punctures behind; elytra rather deeply striate *livens*, sp. nov.
- 3 (2). Upper surface aeneous or bronze, sometimes green or with greenish reflections; head impunctate; elytra never deeply striate.
- 4 (11). Upper surface aeneous or bronze; elytra without pale markings.
- 5 (8). Large species (not less than 5.0 mm. long); upper surface aeneous, with greenish or (rarely) bluish reflections.
- 6 (7). Prothorax with a well-developed carina in the hind angles; elytra moderately convex, with strongly rounded sides; legs dark red *kingstoni*, sp. nov.
- 7 (6). Prothorax with a short and often indistinct carina in the hind angles; elytra flat, with gently rounded sides; legs fuscous . . . *nivicola*, Andr.
- 8 (5). Small species (not more than 4.0 mm. long); upper surface aeneous or bronze.
- 9 (10). Elytra aeneous, subovate, with evident shoulders, clearly though lightly striate, the meshes of the microsculpture transverse; venter slightly pubescent *elatum*, sp. nov.
- 10 (9). Elytra dark bronze, oval, shoulders rounded away, striae hardly impressed, the meshes of the microsculpture isodiametric; venter glabrous *cymindulum*, sp. nov.
- 11 (4). Upper surface aeneous or green; elytra with pale markings.
- 12 (13). Elytra with a broad pale margin, meshes of the microsculpture transverse; length about 5.75 mm. *exornatum*, sp. nov.
- 13 (12). Elytra each with a large humeral and a large apical pale spot, meshes of the microsculpture isodiametric; length about 3.5 mm. (elytra often pale, with only dark sutural and transverse areas forming a cross) *pictum*, Fald.
- 14 (1). Elytra without microsculpture; upper surface polished and brassy.
- 15 (16). Head with a few punctures behind; base of prothorax coarsely punctate; elytral striae moderately deep on disk; length nearly 4.0 mm. *radians*, Andr.
- 16 (15). Head impunctate; base of prothorax faintly punctate; elytral striae lightly impressed; length about 3.25 mm. *infans*, sp. nov.

Bembidion livens, sp. nov.

Length : 4.5-5.0 mm.

Black : upper surface very dark blue, with some metallic green reflections.

Head with deep, parallel, uneven furrows, extending on to clypeus, eyes not prominent, antennae nearly reaching middle of elytra, surface smooth, but with a few punctures on each side of vertex. *Prothorax* moderately convex, cordate, a fourth wider than head and fully a third wider than long, sides well rounded in front and rather strongly sinuate at basal fourth, hind angles right, sharp, but hardly projecting laterally, with a well marked carina; median line fairly deep, front transverse impression obsolete, except at middle, hind one vague, basal foveae deep, somewhat removed from hind angles, disk smooth, basal area uneven and with traces of fine puncturation, some transverse striae in front of the foveae, some longitudinal striae at middle. *Elytra* moderately convex, ovate, rather pointed at apex, shoulders well marked, two-thirds wider than prothorax, about a half longer than wide, sides rather strongly rounded, the widest part a little behind middle, the border rounding the shoulder and barely reaching base of stria 5; punctate-striate, the punctures not very clearly defined, the striae fairly deep on disk, rather shallow at sides, but all distinct, scutellary striole and apical stria both fairly developed; intervals a little convex on disk, flat at sides, 3 with two pores adjoining stria 3, just before middle and at two-thirds respectively. The microsculpture of the elytra and prothorax is formed by moderately transverse meshes, very faint on disk of prothorax; on the head the meshes are isodiametric. Venter glabrous, metasternal process bordered at sides only.

Some half dozen blue or blue-black species, allied to this one, have been described from the North-Western Himalayas, but this seems to be the first described from the north-eastern side. It seems to come nearest to *B. aquilum*, Andr., but is of a darker and slightly greener colour; the prothorax is wider, more strongly rounded, and with sharper hind angles; the elytra are wider at middle and more contracted at extremities, the striae not quite as deep, and the punctures, except close to base, less evident.

TIBET : Yatang, 2 ex.; Tropde, 1 ex. (type).

The three examples agree fairly well, except that in one from Yatang, there is a transverse depression across the head. A fourth example from Sikkim (Tangu, 14,000 feet, 27.iv.1924) differs in one or two particulars. The disk of the head is practically without microsculpture, the hind angles of the prothorax project laterally, the elytral striae are shallower and also appear somewhat deformed near apex. For the present I treat this as a variety.

Bembidion hingstoni, sp. nov.

Length : 5.0-5.5 mm.

Black : upper surface aeneous; joint 1 of antennae and legs ferruginous, femora sometimes piceous.

Head with short, fairly deep, parallel furrows, eyes rather flat, antennae reaching basal fourth of elytra, surface impunctate. *Prothorax* slightly convex, cordate, a fifth wider than head and fully a third wider than long, sides well rounded in front, sinuate at a fourth from base, hind angles right, sharp, not projecting laterally, with a more or less distinct carina; transverse impressions and the median line between them all well marked, though not deep, basal foveae short but deep, surface smooth, base usually more or less vaguely striate, with some microscopic punctures, visible chiefly on basal area. *Elytra* moderately convex, subovate, though with square shoulders, rather more than a half wider than prothorax and as much longer than wide, sides well rounded, the widest part behind middle, border rounding shoulder, but barely reaching base of stria 5; striae generally moderately

impressed, very finely and indistinctly punctate, the outer a little shallower than the inner ones, 2 a little deeper close to base, scutellary striole rather short, apical stria short but distinct; intervals slightly convex on disk, flat at sides, 3 with two pores adjoining stria 3, at about a third and two-thirds respectively. The microsculpture of the elytra is very distinct and is formed by isodiametric meshes; on the disk of the prothorax the meshes are faint and tend to become a little wider than long; head with isodiametric meshes, but vertex quite smooth. Venter glabrous, metasternal process with a narrow border at sides, wide and ill-defined at extremity.

In appearance not unlike the common alpine *B. redtenbacheri*, Dan., but with red legs, and slightly larger. Head wider and eyes less prominent; prothorax evidently wider, front transverse impression deeper, the carina in hind angles slighter, the base (except under the microscope) impunctate, elytra a little longer and more finely striate.

TIBET: Kampa Dzong, 1 ex.; Tinki Dzong, 4 ex.; Trangso Chumbab, 5 ex.; Kyishong, 12 ex. (type); Pangle, 6 ex.; Pang La, 2 ex.; Lamna La, 4 ex.

Among the numerous specimens from these localities some variability is noticeable. The striation of the elytra is at most only moderately deep, and in some examples from the Lamna La the striae are hardly impressed at all. Differences can also be seen in the prothorax, especially in the width at base, the degree of development of the carina in the hind angles, and the depth of the basal foveae. I have not, however, been able to distinguish more than one species.

***Bembidion elatum*, sp. nov.**

Length: 3.5-3.75 mm.

Black: upper surface aeneous.

Head with short, moderately deep, parallel furrows, ending behind in two shallow rounded pores, which lie between the front supraorbitals, eyes rather flat, antennae not reaching far beyond base of elytra, surface impunctate. *Prothorax* subcordate, moderately convex, a fourth wider than head and a third wider than long, sides gently rounded in front and slightly sinuate before base, hind angles right, very sharp, not projecting laterally, with only a rudimentary carina; median line fine, front transverse impression obsolete, hind one moderately deep, basal foveae fairly deep, a small deeper impression on each side, just within the carina, surface vaguely striate, transversely on disk, longitudinally along middle of base. *Elytra* flat, subovate, with rather square shoulders, two-thirds wider than prothorax, a half longer than wide, sides gently rounded, border rounding shoulder to base of stria 5; lightly striate, the striae with fine vague punctures, outer striae somewhat fainter, 5 deeper close to base, scutellary striole rather short, apical stria distinct; intervals nearly flat, 3 with two pores adjoining stria 3, at about a half and three-quarters. Microsculpture very distinct throughout, the meshes moderately transverse on the elytra, isodiametric on head and prothorax. Metasternal process narrowly and indistinctly bordered, ventral surface with some slight, scattered pubescence.

This species would apparently belong to the subgenus *Trichoplataphus* but in form and colour it resembles *B. fellmanni*, Mann., than which it is a little smaller and narrower. The frontal furrows are shallower, the prothorax narrower and more contracted behind, the elytra a little narrower, flatter, with less rounded sides, the border at shoulder only reaching stria 5, the microsculpture more impressed and the surface consequently duller. There is no nearly allied Indian species.

TIBET: Pangle, 1 ex.; Tashidzom, 4 ex.

Bembidion cymindulum, sp. nov.

Length : 4.0 mm.

Piceous : upper surface very dark bronze.

Head with moderately deep, parallel furrows, extending on to clypeus, eyes flat, antennae rather stout, reaching basal fourth of elytra, surface impunctate. *Prothorax* cordate, moderately convex, a little wider than head and a third wider than long, sides moderately rounded in front and sinuate not far from base, hind angles right, sharp, and projecting a little laterally, without carina; median line moderately impressed, front transverse impression very shallow, hind one fairly deep, as are the basal foveae, which adjoin the hind angles, disk vaguely, basal area more strongly, irregularly striate, but not punctate. *Elytra* somewhat depressed, oval, the shoulders practically rounded away, a little more than a half wider than prothorax, and as much longer than wide, sides rather strongly rounded, border rounding shoulder and reaching stria 5, bent slightly back at its extremity, but not angulate; punctate-striate, the striae (except 1) hardly impressed, except on middle of disk, the punctures faint, the outer striae very vaguely indicated, scutellary striae very short, apical stria fine, but fairly distinct; intervals flat, sutural one somewhat raised, 3 with two pores at a third and three-fourths, the front more conspicuous than the hind one, both adjoining stria 3. Microsculpture very pronounced, isodiametric throughout, rather less strongly impressed on head and prothorax than on the elytra. Underside glabrous, metasternal process unbordered, a slight transverse impression behind it.

A very isolated form, with no near allies known to me. The microsculpture suggests a relationship with *B. pygmaeum*, F., but there seems no further connexion. Some characters indicate the subgenus *Plataphus*, but I know of no species in that group at all resembling the new one.

TIBET : Kyetrak, 1 ex. (type); Phuse La, 1 ex.

Bembidion exornatum, sp. nov.

Length : 5.5–6 mm.

Piceous beneath; upper surface dark metallic green, elytra with a wide, dark flavous margin, extending inwards to stria 5 near base and to stria 6 at middle, slightly wider at apex; joints 1 and 2 of antennae, basal joints of palpi, and legs ferruginous (knees darker, tibiae paler), rest of antennae fuscous.

Head with single, deep, but very uneven, parallel furrows, extending on to clypeus, eyes moderately prominent, antennae rather slender, reaching basal fifth of elytra, surface impunctate, with a small central pore on vertex. *Prothorax* cordate, very convex, evidently wider than head and fully a half wider than long, sides strongly rounded in front and sharply sinuate at a fourth from base, hind angles right, sharp, and projecting a little laterally, with a well marked carina; median line moderately impressed, both transverse impressions deep, hind one longitudinally striate, basal foveae fairly deep, with one or two transverse striae, surface vaguely transversely striate, basal area uneven. *Elytra* convex, oval, but with well marked shoulders, rather more than a half wider than prothorax, a half longer than wide, sides gently rounded, border rounding shoulder and extending to base of stria 5; striate-punctate, the inner striae faintly impressed, the outer ones formed by the fine punctures, 5 to 7 very faint, but traceable throughout, scutellary striae short, apical stria fairly deep, joining 7; intervals flat, 3 with two well marked pores at a third and two-thirds, adjoining stria 3. The microsculpture of the elytra is formed by a reticulation of very wide meshes; both prothorax and head are practically without microsculpture. Underside glabrous, metasternal process bordered at sides only.

Nearly allied to *B. amnicola*, Sahlb., and about the same size, but with darker antennae, and the wide pale elytral border reaching the base. The frontal

furrows are more uneven, the base of the prothorax striate, without punctures, its sides sinuate further from base, the elytral striae hardly impressed, the punctures much finer.

TIBET : Jikkyop, 2 ex.

Bembidion infans, sp. nov.

Length : 3.0-3.5 mm.

Black, upper surface metallic green; antennal joints 1 and 2, with base of 3 and 4, and legs rather dark ferruginous, coxae more or less piceous, rest of antennae and palpi fuscous.

Head with fairly deep, rather smooth frontal furrows, diverging strongly behind, eyes only moderately prominent, antennae short and stout, surface impunctate. *Prothorax* cordate, convex, a fourth wider than head and a third wider than long, base bordered, sides well rounded in front and gently sinuate at about a fourth from base, hind angles sharp, slightly acute, and projecting a little laterally, with a short carina; median line faint, not reaching extremities, front transverse impression shallow, hind one fairly deep, basal foveae deep, adjoining the angles, surface smooth, with a very few punctures along the course of the hind impression. *Elytra* convex, ovate, the shoulders rounded, a half wider than prothorax and a little more than a half longer than wide, sides gently rounded, the border only reaching a point opposite stria 6; punctate-striate, the striae rather lightly impressed, barely reaching base, the outer ones disappearing behind, scutellary striae moderately long, apical stria fairly deep; intervals slightly convex, 3 with two pores on the interval, at a third and two-thirds. No microsculpture. Underside glabrous, metasternal process conspicuously bordered.

Like so many other Himalayan species this one does not fit into any of the palaearctic subgenera. However, apart from the practical absence of any basal border on the elytra, it is not unlike *B. lampros*, Herbst, and of about the same size, though of a more sombre colour. The frontal furrows are less deep, the prothorax less contracted behind, so that the base is quite as wide as the apex, the basal area less roughly sculptured, the elytra a little more lightly striate, and with an apical stria present. Among Eastern species it is most nearly allied to *B. radians*, Andr.

TIBET : Yatang, 9 ex.

Diplous nortoni, sp. nov.

Length : 9.5-11.0 mm.

Black : apex of palpi ferruginous.

Head convex, with deep uneven frontal foveae, diverging slightly behind and reaching a little beyond mid-eye level, clypeal suture obsolete, genae oblique, a deep, faintly punctate constriction not very far behind eyes, which are only moderately prominent, mentum with a short bifid tooth, palpi slender, antennae reaching basal third of elytra, surface smooth, a few faint striae near eyes. *Prothorax* moderately convex, cordate, a fourth wider than head and nearly a third wider than long, base slightly emarginate at middle, apex truncate, sides with a fine reflexed border, well rounded in front, sinuate at a fifth from base, a seta on hind angle and another rather before middle, hind angles right and sharp; median line impressed at middle, front transverse impression rather slight, hind one a little deeper, basal foveae small, deep, and rounded, a little removed from both sides and base, middle of base, lateral channels, and front transverse impression rather finely and lightly punctate, the punctures more densely placed around and in the basal foveae, disk vaguely transversely striate. *Elytra* flat, elongate-ovate and widest just behind middle, three-fourths wider than prothorax and as much longer than wide, sides very gently rounded, not sinuate before apex; punctate-striate, the punctures visible only on basal half of disk, the striae moderately

impressed on disk, rather lightly at sides, 1 and 2 joining at base, 1, 5, and 8 all reaching apex; intervals somewhat convex on disk, nearly flat at sides, 3 with three equally spaced pores, adjoining stria 3, marginal series subinterrupted at middle, the pores very small. Microsculpture of elytra formed by isodiametric meshes, the head and prothorax practically without any. Metepisterna and sides of sterna punctate, venter with traces of puncturation only at sides of base. Tarsal joints a little transverse, joint 4 deeply emarginate, but hardly bilobed.

Of the four known Asiatic species of this genus, *D. sibiricus*, Motsch., and *D. caligatus*, Bates, are insects with a strongly sculptured upper surface and pale legs. *Platidius przewalskii*, Sem., described from a single ♀ specimen from Burkhan Buddha, a little south-west of Koko Nor, has dilated labial palpi, a deep fovea on the vertex, and two punctures only on elytral interval 3. There remains only *D. depressus*, Gebl., from the Altai Mountains, which is unknown to me in nature; it appears to differ from the species here described in its smaller size, the strong puncturation of the neck constriction, and the front transverse impression of the prothorax covered with punctures.

TIBET: Tashidzom, 4 ex.

***Zabrus malloryi*, sp. nov.**

Length: 13.5–15.5 mm.

Black: palpi and antennae towards apex piceous.

Body apterous.

Head wide, convex, slightly dilated behind eyes, which are very flat, frontal impressions rather shallow, short, and linear, their front ends joined by the fine clypeal suture, clypeus with an arcuate ridge in front (convex backwards), behind which is a transverse depression, sides with a few oblique striae in front and some fine puncturation behind, antennae just reaching base of prothorax. *Prothorax* quadrate, convex, a half wider than head and as much wider than long, widest at about middle, extremities slightly and widely emarginate, base wider than apex, sides gently rounded, a little more strongly near front angles, finely bordered, narrowly explanate in front, more widely behind, a seta on each side at apical third, hind angles a little obtuse and slightly rounded; median line short and faint, front transverse impression entire, but rather vaguely defined, hind one deep, basal foveae present but not strongly impressed; surface vaguely transversely striate, sides and base finely and closely punctate. *Elytra* ovate, convex, about a fifth wider than prothorax, a half longer than wide, basal border very clearly defined, with a slight, obtuse tooth at shoulder, sides with a very fine reflexed border, slightly sinuate behind shoulder and rather strongly before apex, marginal channel a little wider in front; striae finely but very clearly incised, almost imperceptibly crenulate, intervals flat, marginal series widely interrupted, surface smooth. Microsculpture very fine, the meshes isodiametric, very distinct in ♀, fainter in ♂, especially on head and prothorax. *Sterna* at sides and episterna punctate; prosternal process plurisetose; metepisterna as long as wide. *Venter* punctate at sides of base, the segments without transverse sulci, plurisetose, apical segment transversely strigose, with two setae (♂♀) on each side.

The species seems to be allied to *Z. przewalskii*, Sem., and *Z. potanini*, Sem., the former from N.E. Tibet, the latter from Western China (Vide 1889, Hor. Soc. Ent. Ross. 23: 380, 382); neither of these is known to me in nature, and both appear to have the elytra more deeply striate. Further in *prezawalskii* the head is rugose-punctate, the frontal impressions and clypeal suture are deep, and the prothorax is strongly punctate in front, while in *potanini* the hind angles of the prothorax are acute and project a little laterally.

TIBET : Phari; Tuna; Kampa Dzong; Lingga; Tinki Dzong; Dinka La; Tingri; Lamna La; Kyetrak. Many examples.

***Harpalus tibeticus*, sp. nov.**

Length : 9-9.5 mm.

Black : apex of palpi and joints 1 and 2 of antennae ferruginous, rest of antennae and legs piceous, tarsi a little lighter.

Head convex, smooth, genae glabrous, clypeal suture fine, ending on each side in a moderately deep rounded pore, eyes not prominent, antennae not quite reaching base of prothorax, tooth of mentum very short and obtuse. *Prothorax* moderately convex, quadrate, nearly a third wider than head, nearly a half wider than long, base truncate, apex a little emarginate, narrower than base, sides unisetose, finely bordered and very gently rounded, not sinuate behind, hind angles about right, but rounded; median line fine, transverse impressions slight, basal foveae fairly deep, midway between middle and margin, surface generally smooth, the foveae closely and finely punctate, the punctures extending vaguely to middle and sides of base. *Elytra* moderately convex, very little wider than prothorax, a little more than a half longer than wide, basal border entire and produced on each side to form a sharp tooth at shoulder, sides finely bordered and gently rounded, deeply emarginate before apex, the outer angle of the emargination forming a sharp, obtuse tooth; striae only moderately deep, shallower on disk, almost imperceptibly crenulate, 4 and 5 diverging strongly close to base, intervals slightly convex, 3 with two (but sometimes one and sometimes three) large, irregularly disposed pores just behind middle, surface shiny in ♂, dull in ♀. Microsculpture isodiametric throughout, the elytra much more strongly sculptured in ♀ than in ♂, disk of prothorax and that of head almost smooth. Prosternum punctate, prosternal process vaguely bordered, setose, metepisterna a half longer than wide, finely and vaguely punctate; venter with its basal segments finely punctate and setulose in the middle, last three joints smooth, apical segment (♂♀) with two setae on each side; meta-femora plurisetose.

In the apical emargination and humeral tooth of the elytra resembling the Caucasian *H. retowskii*, Reitt., but a much smaller insect, the prothorax less contracted behind and with deeper foveae, the elytra with shallower striae and (generally) two deep punctures on interval 3.

TIBET : Tasam, 5 ex.

***Harpalus lepcha*, sp. nov.**

Length : 8 mm.

Piceous above, brown beneath : mandibles, palpi, antennae, lateral margins of prothorax, apical border of elytra, and legs ferruginous.

Head convex, smooth, clypeal suture fine, terminating at each extremity in the punctiform frontal foveae, eyes rather flat, supraorbital pores not far removed from them, antennae extending a little beyond base of prothorax, mentum with a short tooth. *Prothorax* convex, quadrate, about a third wider than head and a fourth wider than long, base finely bordered, truncate, wider than apex, sides unisetose, with a fine, reflexed border, gently rounded in front, a little contracted and nearly straight behind, hind angles slightly obtuse and a little rounded; median line and transverse impressions all faint, basal foveae shallow, the surface a little raised on each side between them and side margins, surface smooth, basal area finely and closely punctate, confluent in the foveae, the punctures extending some little way forward along lateral channels. *Elytra* convex, slightly wider than prothorax and a half longer than wide, shoulders hardly perceptibly dentate, sides very gently rounded, apex strongly sinuate on each side; striae impunctate, moderately impressed, much deeper near apex, intervals nearly flat, 3 with a pore at apical fourth, surface smooth and shiny (♂).

Microsculpture of elytra formed by excessively fine transverse lines, that on prothorax practically, and on head quite invisible. Underside smooth, sides of metasternum and (very vaguely) metepisterna punctate, latter moderately long, prosternal process setose, ventral segments bisetose, including last segment (♂), 3 with some minute punctures but no visible setae on each side of middle.

Very near the common palaearctic *H. latus*, L., but smaller, narrower, and with the pale parts darker in colour, the prothorax more contracted behind, the angles less rounded and the surface adjoining them not explanate, the elytra more parallel, practically without tooth at the shoulder, the margin much more deeply sinuate near apex.

SIKKIM : Phadamchen, 1 ex. ♂.

***Harpalus irvinei*, sp. nov.**

Length : 6.5-7.5 mm.

Black, shiny : palpi, antennae, and tarsi ferruginous, rest of legs piceous.

Head convex, wide, clypeal suture obsolete, frontal foveae rounded, moderately deep, eyes very flat, separated from buccal fissure, the supraorbital pore distant from eye, antennae hardly reaching beyond base of prothorax, mentum with a sharp tooth, joint 2 of labial palpi plurisetose. *Prothorax* convex, subquadrate, fully a third wider than head, a half wider than long, base bordered, a little emarginate, very slightly wider than apex, which is truncate, sides unisetose, finely bordered, gently rounded in front and equally gently sinuate behind, the hind angles rectangular; median line very fine, front transverse impression conspicuous, rather deep at sides, distant from margin, hind one evident only at middle, basal foveae fairly deep and well defined, subrugose, finely but not closely punctate, the punctures sometimes extending to middle of base. *Elytra* convex, oval, rather more than a third wider than prothorax, not quite a half longer than wide, shoulders without tooth, sides rather strongly rounded, apical sinuation obsolete; striae moderately impressed, impunctate, intervals slightly convex, 3 without pore, marginal series widely interrupted, surface smooth. No microsculpture, but the upper surface of the body is microscopically punctulate. Underside smooth, prosternal process glabrous, metepisterna only a little longer than wide, last ventral segment with two setae on each side.

This species presents some characters which are unusual in the genus; it will be readily recognised by the peculiar form of the prothorax, with its sinuate sides and rectangular hind angles, and by the absence of any pore on elytral interval 3.

TIBET : Gautsa, 3 ex.; Rongshar Valley, 1 ex. There is also an example without label in the collection of the Madrid Museum of Natural Sciences, which came, I think, from the Sikkim-Tibet frontier near the Jelep La. In the Rongshar Valley example the prothorax is almost impunctate, and the hind angles of the prothorax project a little laterally.

***Harpalus metarsius*, sp. nov.**

Length : 7.0 mm.

Piceous, underside and elytra sometimes brownish : base and apex of palpi, joints 1 and 2 of antennae, side border of prothorax, apical border of elytra, and legs (femora occasionally darker) more or less ferruginous.

Head convex, clypeal suture fine, frontal foveae small and rounded, eyes rather flat, separated somewhat narrowly from buccal fissure, supraorbital pore close to eye, antennae barely reaching base of prothorax, mentum with a short sharp tooth. *Prothorax* convex, quadrate, a third wider than head and a half wider than long, base truncate, finely bordered

at sides, wider than apex, sides unisetose, finely bordered, gently and almost uniformly rounded, hind angles slightly obtuse and rounded; median line visible only at middle, transverse impressions faint, basal foveae small and shallow, the punctures extending very vaguely to sides, middle and lateral channels. *Elytra* convex, not much wider than prothorax, about a half longer than wide, shoulders with a sharp, minute tooth (not always developed), sides gently rounded, apex conspicuously sinuate on each side; striae rather fine, impunctate, intervals slightly convex, depressed on each side near apex, 3 with a small pore not far from apex, surface smooth, rather dull. Microsculpture isodiametric, clear on the elytra, visible on sides of head and prothorax. Underside nearly smooth, prosternal process setose, metepisterna bordered, longer than wide, ventral segment 3 with a patch of hairs on each side of median line, 4 and 5 with three or four setae, similarly placed, last segment with two marginal setae on each side.

Allied to *H. salinulus*, Reitt., and *H. polychromus*, Tchitch.; much smaller than the latter, and differing from the former in the colour of the antennae, form of the elytra at apex, etc.

TIBET: Tinki Dzong, 5 ex.; Kyishong, 1 ex.; Shekar, 3 ex.

Coleolissus noeli, sp. nov.

Length: 8 mm.

Black, slightly iridescent, shiny: palpi, antennae, and lateral border of prothorax ferruginous, legs flavous.

Head small, convex, smooth, clypeal suture fairly deep, continued obliquely on each side towards eye, eyes rather flat, antennae extending a little way beyond base of prothorax, mentum with a short tooth. *Prothorax* convex, subquadrate, nearly two-thirds wider than head, a third wider than long, base wider than apex, its sides bordered and slightly oblique, sides unisetose, narrowly bordered, explanate from near front angle, the explanate part widening rapidly to about basal fourth, gently and uniformly rounded, hind angles obtuse but hardly rounded; median line very fine, connecting the two transverse impressions, front one faint, hind one fairly deep, basal foveae shallow, basal area depressed, its sides uneven, finely punctate, the punctures extending forward along the explanate area, disk smooth. *Elytra* convex, ovate, pointed at apex, base truncate, its border rather distant from margin, bisinuate and forming at shoulder a sharp angle with side border, a fourth wider than prothorax, a little more than a half longer than wide; striae moderately deep, impunctate, intervals somewhat convex on disk, much more convex near apex, inner margin of 8 subcarinate near base, 3 with three or four minute pores adjoining stria 2, surface smooth. No microsculpture, except some vestiges on head. Underside smooth, prosternal process bisetose at apex, metepisterna longer than wide, not much contracted behind, last ventral segment (♀) with two setae on each side.

Smaller than the comparatively common Indian species, *C. iris*, Andr., and similarly coloured, though much less iridescent. Head with deeper clypeal suture; prothorax more evidently explanate at sides, hind angles hardly rounded, punctures finer and less dense; elytra much less deeply striate, with very inconspicuous punctures on interval 3.

SIKKIM: Kalimpong, 1 ex. ♀.

Trichotiehnus aquilo, sp. nov.

Length: 8-9 mm.

Black, shiny: palpi, antennae, lateral margin of prothorax, apical border of elytra, and legs ferruginous, femora sometimes darker.

Head convex, smooth, median part of clypeal suture fine, the oblique lateral parts much

deeper, eyes moderately convex, antennae extending a little beyond base of prothorax, mentum edentate, paraglossae glabrous, joint 2 of labial palpi plurisetose. *Prothorax* subquadrate, a fourth wider than head and about a half wider than long, base finely bordered, truncate, a little wider than apex, sides finely bordered, unisetose, gently rounded, a little more strongly in front, nearly or quite straight behind, without sinuation, hind angles obtuse but very little rounded; median line very fine, transverse impressions shallow, visible at middle, sides of base as far as middle gently depressed, disk smooth, margins—but chiefly the sides of basal area—finely and closely punctate. *Elytra* ovate, a fourth wider than prothorax, rather more than a half longer than wide, widest a little behind middle, sides rather strongly sinuate before apex; striae fairly deep, impunctate, intervals moderately convex, much narrower and more convex near apex, 3 with a single pore at two-fifths from apex, adjoining stria 2, surface smooth. No microsculpture on elytra and only traces on head and prothorax. Underside practically smooth, prosternal process with two or three setae at apex, metepisterna elongate, third ventral segment smooth and glabrous in middle between metatrochanters, last segment with 1 seta (♂), 2 setae (♀) on each side.

Larger than *T. birmanicus*, Bates, middle of clypeal suture much finer, prothorax wider, its sides not sinuate behind, basal area much more densely punctate, elytra less deeply striate, the pore on interval 3 placed a little further back.

SIKKIM: Darjeeling, 3 ex. ASSAM: Rotung, Bank of Dihang River, 1400 feet, 22–30.xii.1911 (*S. W. Kemp*, Abor Expedition, Ind. Mus.), 3 ex.

Trichotichnus hingstoni, sp. nov.

Length: 7–7.5 mm.

Upper surface black, shiny (♂♀), somewhat iridescent; underside brown or piceous; palpi, antennae, legs, lateral borders of prothorax, apical border and epipleura of elytra ferruginous.

Head convex, clypeal suture moderately impressed at middle, the oblique side parts deeper, eyes rather flat, the genae evident, antennae just reaching base of prothorax. *Prothorax* convex, about a third wider than head and as much wider than long, base slightly emarginate, faintly bordered at sides, a little wider than apex, sides very finely bordered, the lateral seta at a fourth from apex, moderately and nearly uniformly rounded from apex to base, hind angles a little obtuse but sharp; median line very fine, transverse impressions obsolete, basal foveae just visible, surface smooth, not depressed near hind angles, a few very minute punctures at each side of base. *Elytra* convex, ovate, a little pointed at apex, a third wider than prothorax, not quite a half longer than wide, basal border without tooth at shoulder, sides rather strongly rounded, slightly sinuate before apex; striae fine, impunctate, similar throughout, 5 a little deeper close to base; intervals very slightly convex, 3 with a pore behind middle, marginal series interrupted at middle, surface smooth. Microsculpture of the elytra consisting in fine, barely visible, transverse lines; that on prothorax forming wide transverse meshes; head quite smooth. Underside smooth; prosternal process setose, metepisterna rather longer than wide, third ventral segment minutely punctate and setulose in the middle, apical segment with two marginal setae on each side.

The rounded sides of the prothorax give this insect an appearance quite different from that of the other species of *Trichotichnus*, and perhaps, when a more thorough study of the Himalayan Harpalini is possible, a new genus may be required. It is to be noted that in the palaearctic species *T. laevicollis*, Duft., *T. longitarsis*, Moraw., and *T. congruus*, Motch., the third ventral segment is also minutely punctate in the middle.

SIKKIM: Darjeeling, 4 ex.; Gangtok, 1 ex.

Trichotichnus emarginatus, sp. nov.

Length : 8.0 mm.

This species is very closely allied to *T. hingstoni*, but differs as follows :—

A little larger, but similarly coloured. *Head* with the clypeal suture very lightly impressed, but with shallow rounded frontal foveae. *Prothorax* a little less convex, the basal half of the sides practically straight, lateral pore at a third from apex, front transverse impression moderately deep at middle, basal area flattened at sides, the puncturation closer and much more evident, extending along lateral channels to front angles, a few coarser punctures in the shallow basal foveae. *Elytra* less convex, a little longer, sides less rounded, a conspicuous emargination on each side before apex, striae deeper, marginal series of pores more widely spaced at middle, but not interrupted. Microsculpture similar, but even fainter. Underside similar.

SIKKIM : Darjeeling, 1 ex. ♀.

Trichotichnus glabellus, sp. nov.

Length : 6.5–7.5 mm.

Like the last this species presents many of the characters of *T. hingstoni*, but may be distinguished as follows :—

The size is the same, but the colour is darker, the prothorax uniformly black, joint 1 of the antennae, the femora, and sometimes the tarsi piceous. *Head* a little narrower, clypeal suture and its lateral extensions very fine, shallow frontal foveae present. *Prothorax* less convex, bordered throughout (though only faintly at middle of front margin), sides straight behind, lateral seta a little before middle, hind angles obtuse but sharp, transverse impressions evident, though shallow, sides of base hardly flattened, the basal foveae moderately impressed, finely though not very closely rugose-punctate, some more sparse puncturation extending vaguely towards middle and along lateral channels. *Elytra* less convex, narrower, the sides less rounded, with a similar faint emargination before apex, the striae slightly deeper, the marginal series of pores less evidently interrupted at middle. The microsculpture of the elytra is a little more visible, but both prothorax and head are practically smooth. On the underside the middle of the third ventral segment between the metatrochanters is smooth and glabrous.

TIBET : Chumbi Valley, 5 ex.; Yatang, 3 ex.; Phari, 1 ex. SIKKIM : Lachen, 1 ex. I have also a solitary example in my collection labelled "Darjiling," but I am doubtful about its exact provenance.

Acupalpus sikkimensis, sp. nov.

Length : 4.4–7.5 mm.

Black, shiny, underside piceous to brown : palpi, joints 1 and 2 of antennae (rest fuscous) and legs flavous, side margins of prothorax and apical margin of elytra more or less ferruginous.

Head convex, smooth, clypeal suture lightly impressed, the oblique furrows on each side deep, eyes only moderately prominent, antennae extending a little beyond base of prothorax. *Prothorax* convex, subquadrate, a fourth wider than head and about as much wider than long, base arcuate (convex backwards), its sides very oblique, apex slightly emarginate, sides narrowly bordered, gently rounded, nearly straight behind, the seta at apical fourth, just in front of widest part, hind angles evident and reflexed, though obtuse and strongly rounded; median line and transverse impressions very faint, sides of base depressed, coarsely and not very closely punctate, surface otherwise smooth. *Elytra* convex, subquadrate, with very square shoulders, a third wider than prothorax and two-

thirds longer than wide, the margin only faintly sinuate before apex; striae moderately impressed, impunctate, intervals slightly convex, 1 somewhat raised, 3 with a pore at apical third, adjoining stria 2, marginal series widely interrupted at middle, surface smooth. No appreciable microsculpture. Prosternum and its process glabrous, metepisterna smooth, bordered, nearly twice as long as wide; ventral segments 4 and 5 with one or two additional setae at middle, apical segment setulose, the margin in ♂ with one seta, in ♀ with two setae, on each side.

In size and shape very much like the Japanese *A. inornatus*, Bates. The colour is black instead of ferruginous, and there is no trace of iridescence; the head and elytra are very similar, but the prothorax is relatively larger, the hind angles are more reflexed, and the surface within them is coarsely instead of finely punctate.

SIKKIM: Rangli, 2 ex. Mr. H. Stevens took examples of the species in the Darjeeling district, at Gopaldhara, 3500–5000 feet, and at Namsoo, 2000 feet, 1919–1920.

PSYCHRISTUS, gen. nov.

Body winged. *Head* glabrous, eyes glabrous, narrowly divided from buccal fissure, a single supraorbital seta on each side, level with and a little removed from hind margin of eye, frontal foveae very deep, continued obliquely on each side to eye, antennae short, moniliform, pubescent from and including joint 4, labrum transverse, sexsetose, mandibles short and wide, slightly hooked at apex, mentum with a fairly deep emargination and a moderately sharp tooth, not quite so long as the lobes, ligula rather narrow, bisetose, paraglossae extending a little beyond it and separated from it by a deep incision on each side, maxillae hooked at apex, apical joint of palpi acuminate, in the maxillaries nearly twice as long as penultimate, in the labials hardly longer than penultimate, which has two setae placed very close together on inner margin. *Prothorax* subquadrate, a single lateral seta on each side, placed just before middle. *Elytra* glabrous, without or with only the rudiment of a scutellary striae between striae 1 and 2. *Prosternum* glabrous, its process unbordered; metepisterna long and strongly contracted behind. *Venter* without any punctate and pubescent impression at base, the segments bisetose, apical segment also bisetose and fringed with minute hairs. *Metafemora* with two setae near hind margin, one close to base; tarsal joints glabrous on upper surface, meso- and metatarsal joints not outwardly grooved, joint 4 slightly emarginate, joint 5 glabrous beneath.

I have been able to detect no ♂ characters and I believe all the examples seen of both the species described below are ♀♀. The genus appears to be nearly allied to *Tachycellus*, and, should the ♂ prove to have the pubescent ventral fovea characteristic of that genus, would be distinguished from it chiefly by the different form of the prothorax and the glabrous prosternum. Provisionally I place it near *Lioholus*, Tchitch.

GENOTYPE *Psychristus liparops*, Andr.

Psychristus liparops, sp. nov.

Length: 3.75–4 mm.

Black, shiny: palpi, joints 1 to 3 of antennae (rest brown), legs, apical border of elytra, and apex of venter ferruginous.

Head convex, smooth, clypeus with a slight transverse depression, clypeal suture moderately impressed in the middle, very deep at sides, an oblique depression on each side of vertex, eyes not prominent, antennae gradually dilated towards apex, reaching base of prothorax. *Prothorax* very convex on front of disk, where the sides are strongly declivous to the front angles, a little wider than head and a third wider than long, base truncate,

with its sides somewhat oblique, hardly wider than apex, sides very finely bordered, gently rounded in front and faintly sinuate before the hind angles, which are a little obtuse, but hardly rounded; median line and transverse impressions rather shallow, basal foveae deep, rounded, surface smooth, basal area moderately closely punctate, more conspicuously in the foveae, the puncturation extending vaguely to all the impressions, including the lateral channels. *Elytra* convex, ovate, three-fourths wider than prothorax and rather more than a half longer than wide, base emarginate, with a large umbilicate pore on each side near the origin of stria 2, shoulders not dentate, margin slightly sinuate before apex; finely striate-punctate, but the inner striae are very slightly impressed, 1 bending inwards towards the suture near base, the outer striae formed by fine punctures only, 7 impressed and with a large pore near apex, 8 very deep on apical half, scutellary striae represented by two or three punctures; intervals flat, 3 without any setiferous pores. No microsculpture. Underside practically smooth, with the exception of the proepisterna, which are very coarsely punctate.

TIBET: Chumbi Valley, 1 ex. SIKKIM: Lachung, 2 ex., and Gopaldhara, 1 ex. (both *H. Stevens*).

***Psychristus discretus*, sp. nov.**

Length: 3.75–4.25 mm.

This species resembles that just described in size and colour, but the lateral border of the prothorax and the antennae throughout are ferruginous. In other respects it differs as follows:—Head without oblique depressions at sides of vertex. Prothorax a little wider and a little less contracted behind, the median line and front transverse impression somewhat deeper, the middle of base a little more closely punctate. *Elytra* similar in shape, but with moderately deep impunctate striae, the scutellary striae wanting, interval 3 with a pore at about two-fifths from apex adjoining stria 2. The proepisterna are smooth, instead of being coarsely punctate.

SIKKIM: Phadamchen, 1 ex. KUMAON: West Almora, 10 ex. (*H. G. Champion*).

***Amara* (in sp.) *algida*, sp. nov.**

Length: 6.25–7 mm.

Bronze above, ♂ shiny, ♀ dull, piceous beneath with metallic reflections; joints 1 and 2 of antennae ferruginous, tibiae more or less rufous.

Head fairly wide, smooth, frontal foveae shallow, clypeus not bordered, tooth of mentum bifid, eyes rather flat, with two supraorbital setae. *Prothorax* convex, gradually dilated from apex to base, about two-thirds wider than head and as much wider than long, front angles evident but somewhat rounded, sides narrowly bordered and gently rounded, base bordered at sides only, the pore a little removed from the angle, which is right but slightly rounded; median line fine, inner basal impression deep, punctiform, longer than wide, distant from margin, outer one oblique (outward and backward) and sometimes rather lightly impressed, an oblique impression (outward and forward) on each side, surface smooth, basal area minutely and vaguely rugose-striate, but impunctate. *Elytra* convex, ovate, slightly wider than prothorax and a half longer than wide; striae finely impressed and minutely crenulate, not deeper at apex, scutellary striae developed, without any umbilicate pore, intervals flat, marginal series of pores widely interrupted. Microsculpture isodiametric. Underside smooth; prosternal process bordered, glabrous; metepisterna a third longer than wide. Protibial spur simple; mesotibiae not toothed; metatibiae ♂ inwardly fringed with a dense row of hairs. The apical ventral segment has a single seta on each side in the ♂, 2 setae in the ♀.

Closely allied to the common palaearctic *A. aenea*, de Geer, but on average a little smaller and with only joints 1 and 2 of the elytra ferruginous. On the prothorax the outer impressions are more evident and the pore is further removed from the angle; the elytra are relatively wider and less pointed at apex, the striae much finer. In *A. bamidunyah*, Bates, the elytra are more deeply striate, and the puncturation of the inner striae much more conspicuous.

TIBET: Pangle, 9 ex.; Tingri, 1 ex. In some of the examples and especially in that from Tingri, the intervals of the elytra are slightly convex.

***Amara* (in sp.) *gelida*, sp. nov.**

Length: 5.25–6.75 mm.

Remarkably like the species just described, but smaller and rather narrower. The colour is also similar, but the tibiae are dark and at least a part of antennal joint 3 is usually pale. Head with rather flatter eyes, the frontal foveae only very faintly impressed. Prothorax with sharper and more prominent front angles, inner basal impressions very small, sometimes punctiform, but generally in the form of a very fine short impressed line, outer impressions just visible. The elytra hardly differ except in their relatively narrower form and consequently rather greater length.

This species is not at all unlike *A. famelica*, Zimm., but both the frontal foveae and the basal impressions on the prothorax are much finer and shallower. The two first striae approach one another and often meet a little before apex, and this sometimes happens also in *famelica*.

TIBET: Chumbi Valley, 2 ex.; Yatang, 7 ex.; Rongbuk, 1 ex.; Rongshar Valley, 1 ex.; Tasam, 10 ex.

***Amara* (in sp.) *somervelli*, sp. nov.**

Length: 7.5–9 mm.

Black, upper surface brilliant metallic green; joints 1 to 3 of antennae, with basal half of 4 (rest fuscous), and tips of palpi ferruginous, tibiae and tarsi reddish.

Head smooth, with short slight frontal foveae, diverging behind, clypeus not bordered, tooth of mentum bifid, eyes not prominent, with two supraorbital setae. Prothorax convex, gradually dilated from apex to base, very nearly twice as wide as head and a half wider than long, front angles only slightly rounded, sides narrowly bordered and rather gently rounded, apex bordered throughout, basal border nearly reaching middle on each side, hind angles right and fairly sharp, with the pore close to them; median line fine but clear, transverse impressions slight, inner basal impression short but deep, distant from margin, the surface depressed behind it, outer one oblique, more lightly impressed, surface smooth, with some fine, almost imperceptible puncturation behind the inner impressions. Elytra convex, ovate, slightly wider than prothorax and a little less than a half longer than wide; striae fine, minutely punctate, deeper near apex, scutellary striole very long, with an umbilicate pore at its base, intervals flat, marginal series of pores slightly interrupted. Microsculpture isodiametric, much finer on head and prothorax than on elytra. Underside practically smooth; prosternal process very finely bordered, glabrous; metepisterna a half longer than wide. Protibial spur simple; mesotibiae inwardly setulose, edentate; metatibiae ♂ inwardly fringed with a dense row of hairs. Apical ventral segment with a single seta on each side in the ♂, 2 setae in the ♀.

Near *A. ovata*, F., but distinguishable at once by its bright green colour, the deep inner impressions of the prothorax, and the fine punctate striae of the elytra.

TIBET: Yatang, 5 ex.

***Amara (Celia) faucium*, sp. nov.**

Length : 8-9 mm.

Black, upper surface piceous, with metallic reflections, elytra dark cupreous; joint 1 of antennae, and generally part of 2 and 3, base and apex of palpi, and lateral margins of prothorax more or less ferruginous, legs piceous.

Head rather wide, frontal foveae small, diverging behind, clypeus unbordered, tooth of mentum bifid, eyes moderately prominent, with two supraorbital setae. *Prothorax* convex, gradually dilated from apex to base, rather less than twice as wide as head and about a half wider than long, front angles moderately rounded, sides bordered, gently and evenly rounded, base rather faintly bordered at sides, hind angles practically right, hardly rounded, the pore on each side a little removed from them; median line impressed at middle, transverse impressions vague, both basal impressions fairly deep, the outer one a little oblique, surface smooth, the basal area punctate, the punctures as a rule not quite reaching either the middle, where there are a few longitudinal striae, or the sides. *Elytra* convex, ovate, a fourth wider than prothorax and a third longer than wide; striae moderately impressed, impunctate, but with a suggestion of minute crenulation, scutellary striole developed, no umbilicate pore, marginal series of pores interrupted. Microsculpture isodiametric, much finer on head and prothorax than on elytra. Underside smooth; prosternal process bordered, glabrous; metepisterna about a third longer than wide. Protibial spur simple; mesotibiae ♂ with two slight protuberances near apex on inner margin; metatibiae ♂ without any inner fringe of hairs. Apical ventral segment bisetose on each side in both sexes.

Extremely near *A. rupicola*, Zimm., of about the same size and similarly coloured, but the legs and epipleura of the elytra are piceous, the prothorax is not contracted behind close to the angles, so that these are evidently sharper, and the elytral striae are impunctate, whereas in *rupicola* they are punctate, at least on the basal half, and conspicuously so on the disk.

TIBET : Jelep La, 1 ex.; Phari, 1 ex.; Tuna, 4 ex.; Kampa Dzong, 1 ex. A battered specimen in the British Museum taken by Mr. H. J. Walton during the Tibet Expedition of 1904 at Gyangtse, 13,000 feet, has brown elytra and is evidently undeveloped, but it shows a distinct though very minute puncturation of the elytral striae.

In examining examples of allied species I have had occasion to compare the type of *A. ambigena*, Bates, from the Pangong Valley with specimens of *rupicola* from Koko-Nor, and, as I cannot discover any differences between them, am treating the former as a synonym of the latter.

***Amara (Leiocnemis) sikkimensis*, sp. nov.**

Length : 6.5-7.5 mm.

Piceous, upperside with a faint aeneous tinge; palpi, antennae, tibiae, tarsi and lateral borders of prothorax more or less rufous.

Head smooth, clypeus unbordered, frontal foveae short but deep, diverging behind, tooth of mentum bifid, eyes rather flat, with two supraorbital setae. *Prothorax* convex, two-thirds wider than head, nearly a half wider than long, contracted rather strongly in front, slightly behind, extremities truncate, bordered at sides, base wider than apex, front angles inconspicuous, sides finely bordered and evenly rounded from apex to base, hind angles very slightly obtuse, but sharp, the pore in the angle; median line just visible, transverse impressions very shallow, inner fovea moderately impressed, outer one slight, though evident, surface smooth, basal area finely and fairly closely punctate in and round the foveae, very finely and sparsely in the middle, the punctures hardly reaching lateral margins. *Elytra* convex, ovate, a sixth wider than prothorax, not quite a half longer than wide, shoulders

sharply dentate; striae fine, minutely punctate, not deeper near apex, scutellary striae moderately long, not originating in an umbilicate pore, intervals nearly flat, marginal series of pores widely interrupted. Microsculpture isodiametric, finer and fainter on head and prothorax than on elytra. Prosternum with a small patch of punctures, its process bordered, glabrous; metepisterna a half longer than wide, finely punctate, as are the sides of the metasternum. Protibial spur simple and very short; mesotibiae inwardly edentate; metatibiae ♂ without any inner fringe of hairs; metafemora with two setae on hind margin. Venter punctate at sides of base, apical segment with two setae on each side, close together in the ♂, more distant in the ♀.

Not far removed from the Mongolian *A. hanhaica*, Tchitch., and, though much larger, similar in shape. The frontal foveae, however, are much deeper, the sides of the prothorax are evenly rounded, the hind angles obtuse, and the sides of the base punctate.

TIBET: Rongshar Valley, 1 ex. SIKKIM: Darjeeling, 6 ex.; Phadamchen, 1 ex. The examples from the Rongshar Valley and Phadamchen appear to be immature; the elytra are brassy and the legs very pale.

***Amara (Bradytus) mitis*, sp. nov.**

Length: 8 mm.

Piceous, shiny, upper surface black, with vague metallic reflections; joints 1 to 3 of antennae, palpi, lateral borders and a small area round each hind angle of the prothorax, tibiae, and tarsi more or less rufous.

Head wide, minutely rugose in front, smooth behind, frontal foveae short but fairly deep, diverging behind, clypeus bordered, tooth of mentum short, wide, and undivided, eyes moderately prominent, with two supraorbital setae. *Prothorax* convex, quadrate, a half wider than head and nearly two-thirds wider than long, base somewhat produced in middle, wider than apex, front angles rounded and inconspicuous, sides narrowly bordered, gently rounded, and more contracted in front than behind, hind angles slightly obtuse, sharp, but not dentate or projecting laterally, the pore in the angle; median line fine, transverse impressions obsolete, both inner and outer basal foveae moderately impressed, with a slightly raised area between them, a short oblique carina bounding the outer fovea, surface smooth, the area in and adjoining the foveae finely punctate. *Elytra* convex, hardly wider than prothorax and about a half longer than wide, sides slightly dilated behind shoulders, which are minutely dentate, then faintly rounded and widest at about middle; striae moderately impressed, impunctate, scutellary striae short but distinct, without umbilicate pore, intervals flat, marginal series of pores widely interrupted. Microsculpture isodiametric, only slightly impressed, but distinct on the elytra, just visible on head and prothorax. Prosternum with a shallow, vaguely punctate area, prosternal process very faintly bordered, glabrous; metepisterna and sides of sternum rather vaguely punctate, the former about a third longer than wide. Protibial spur simple; metatibiae ♂ with a slight inner fringe of hairs. Apical ventral segment ♂ with a single seta on each side.

TIBET: Rongshar Valley, 1 ex. ♂.

This insect has not the heavy build commonly associated with a *Bradytus*, but has rather the appearance of a medium-sized *Harpalus*. Nevertheless the clypeal border and the prosternal foveae indicate its position sufficiently clearly. Three species in the subgenus have been described by Tchitcherin from North-East Tibet, and to one of them—*A. chinensis*—this species seems nearly allied. The size is the same, but *chinensis* is dark brown, with strong bronze reflections, apparently without carina in the basal angles of the prothorax, and with the elytral striae finely punctate.

***Amara (Leiomorpha) hypsela*, Andr.**

Length : 5-6 mm.

Piceous, upper surface, especially elytra, rather faintly aeneous : palpi and three basal joints of antennae pale ferruginous, lateral borders of prothorax and apical border of elytra (more or less), and legs dark ferruginous.

Head fairly wide, smooth, frontal foveae short but distinct, clypeus transversely depressed but not bordered, tooth of mentum bifid, eyes not prominent, with two supraorbital setae. *Prothorax* convex, not quite a third wider than head and nearly a half wider than long, base a little wider than apex, both slightly emarginate, front angles not much rounded, sides finely bordered and gently rounded in front, slightly sinuate before base, hind angles practically right, though a little rounded, the pore a little removed from the angle ; median line very fine, front transverse impression fairly distinct, hind one vague, inner fovea small but moderately deep, outer one obsolete, a few punctures in the foveae and near the angles, surface otherwise nearly smooth. *Elytra* convex, ovate, a fourth wider than prothorax and two-fifths longer than wide, sides moderately rounded, shoulders minutely dentate, the tooth projecting forwards rather than outwards ; striae moderately impressed and finely punctate, shallower at apex, scutellary striole very short, without umbilicate pore, intervals flat, pores of the marginal series widely spaced at middle. Microsculpture isodiametric, very clear on the elytra, and, though finer and less impressed, quite distinct on head and prothorax. Prosternum without fovea, the process very lightly bordered (a variable character here), glabrous ; metepisterna hardly longer than wide and very little contracted behind, moderately punctate, as are the sides of the metasternum. Protibial spur simple ; mesotibiae ♂ faintly crenulate along inner margin towards apex ; metatibiae ♂ with a slight inner fringe of hairs towards apex, but not nearly such a dense one as in *Amara sens. strict.* ; metafemora bisetose on hind margin. Apical ventral segment ♂ with one seta, ♀ with two setae on each side.

The original description was inadequate, and therefore I re-describe the species here. I leave it in the subgenus *Leiomorpha* with some doubt, because the prosternal process is not only weakly bordered, but also glabrous, but, so far as I am aware, there is no other subgenus into which it will fit, and I hesitate to suggest a new one.

***Amara (Leiomorpha) charis*, sp. nov.**

Length : 6-6.5 mm.

Extremely near *A. hypsela*, Andr., but a little longer, narrower, and of more graceful build. The colour hardly differs. The head is a little narrower and the eyes rather flatter. The prothorax is narrower, more strongly rounded at sides, more contracted behind, the sinuation of the sides behind stronger and commencing further from base, which is no wider than apex, the sides of base more conspicuously punctate. The elytra are a little narrower, but otherwise do not differ much ; the even intervals are usually a little wider than the odd ones. The prosternal process is also glabrous, though a little more distinctly bordered ; the metepisterna are relatively a little longer ; the mesotibiae of the ♂ have three distinct prominences on the inner margin towards apex.

TIBET : Tinki Dzong, 6 ex.

***Amara (Leiomorpha) sublimis*, sp. nov.**

Length : 6-7.5 mm.

Piceous, the elytra faintly aeneous ; palpi, antennae, borders of prothorax and elytra, and legs more or less rufous.

Head rather wide, smooth, with short, fairly deep frontal foveae, which hardly extend

forward beyond the clypeal suture, clypeus unbordered, tooth of mentum not bifid, eyes moderately prominent, with two supraorbital setae. *Prothorax* convex, about a third wider than head and as much wider than long, base truncate, only slightly wider than apex, front angles rounded and inconspicuous, sides finely bordered and rather gently rounded, very faintly sinuate before hind angles, which are sharply rectangular, with the pore in the angle; median line fine, front transverse impression very shallow, hind one visible only at middle, inner fovea short, linear, lightly impressed, and continued a little way both in front and behind, outer one punctiform, near the angle, often obsolete, surface smooth, basal area very finely and sparsely punctate, the punctures reaching sides but not middle. *Elytra* convex, ovate, about a fourth wider than prothorax and a third longer than wide, shoulders dentate; striae moderately impressed and finely punctate, shallower towards apex, scutellary striae short, not originating in an umbilicate pore, intervals flat, marginal series of pores widely interrupted. Microsculpture isodiametric, finer and fainter on head and prothorax than on the elytra, except that in the ♀ the meshes, though fine, are exceptionally distinct. Prosternum with a small, elongate impression, sometimes punctate, its process bisetose, very vaguely bordered; metepisterna hardly longer than wide, not much contracted behind, lightly punctate, as are the sides of the metasternum. Protibial spur simple; mesotibiae ♂ with two or three slight prominences on inner margin towards apex; metatibiae ♂ without inner fringe of hairs; metafemora trisetose on hind margin. Venter lightly punctate at sides of base, apical segment (♂♀) with two setae on each side.

Very near *A. hypsela*, Andr., and similarly coloured, but a good deal larger. The head is similar, but the prothorax is relatively narrower, the base hardly depressed, the inner foveae linear and shallow; the elytra have the sides less rounded, the striae a little shallower, especially behind; the prosternum bears a slight impression, sometimes punctate, and the ♂, like the ♀, has two setae on each side of the last ventral segment.

TIBET: Phari, 3 ex.; Tuna, 6 ex.; Kampa Dzong, 5 ex. The examples from Phari differ a little from the others, but not enough to warrant another name.

***Amara (Leiromorpha) pinguis*, sp. nov.**

Length: 5–6 mm.

Brown to ferruginous beneath, piceous above, the elytra aeneous: palpi, antennae, legs, lateral margins of prothorax, and apical border of elytra ferruginous.

Head smooth, frontal foveae slight, clypeus unbordered, tooth of mentum wide but not cleft, eyes flat with two supraorbital setae. *Prothorax* convex, about a half wider than head and as much wider than long, rather strongly contracted in front and only a little less behind, so that base is not much wider than apex, very distinctly bordered at sides, front angles rounded, sides narrowly bordered and nearly evenly rounded, hind angles obtuse and rounded, with the pore adjacent to them; median line and transverse impressions all rather slight, both basal foveae usually rudimentary, surface smooth, a few almost imperceptible punctures scattered along the basal area. *Elytra* convex, ovate, not much wider than prothorax and only a fourth longer than wide, sides rather strongly rounded, the widest point at about middle, shoulders minutely dentate; striae rather fine, impunctate, not deeper near apex, scutellary striae very short but clear, without umbilicate pore, intervals nearly flat, marginal series of pores hardly interrupted. Microsculpture isodiametric, very indistinct on head and prothorax. Underside smooth; prosternum ♂ with a slight punctured sulcus, the process bordered, bisetose; metepisterna very little longer than wide, not much contracted behind. Protibial spur simple; mesotibiae ♂ with two slight inner prominences towards apex; metatibiae ♂ without any special fringe of hairs; metafemora quadrisetose behind. Apical ventral segment with a single seta on each side in the ♂, 2 setae in the ♀.

Unlike any *Leiromorpha* known to me, and with an unusual number of metafemoral setae. The rotund form and very short elytra are characters presented by no other Tibetan or Indian species, so that there should be no difficulty in recognition.

TIBET: Phari; Tuna; Kampa Dzong; Dinka La; Rongbuk; Lamna La, many examples, chiefly from Tuna. SIKKIM: Deutang, 1 ex.

***Amara histrio*, sp. nov.**

Length: 5.5 mm.

Brown beneath, piceous above, elytra dark aeneous: palpi, antennae (darker towards apex), and legs ferruginous.

Head convex, frontal foveae very faint and small, clypeus rather vaguely bordered, tooth of mentum bifid, eyes moderately prominent, with two supraorbital setae. *Prothorax* convex, a third wider than head and a half wider than long, moderately contracted in front, slightly behind, the base a little wider than apex, sides finely bordered, very gently rounded, and slightly sinuate before base, hind angles right, but a little rounded, the pore on each side adjacent to them; median line fine, transverse impressions visible but shallow, inner fovea sublinear, though only just visible, and with half a dozen punctures, outer one obsolete, surface otherwise nearly smooth. *Elytra* short, convex, ovate, a fourth wider than prothorax, a little over a third longer than wide, sides moderately rounded, shoulders dentate; striae moderately impressed and finely punctate, shallower towards apex, scutellary striae rudimentary, without umbilicate pore, intervals nearly flat, pores of the marginal series few and widely spaced at middle. Microsculpture isodiametric, finer but clearly visible on prothorax, less visible on head. Underside practically smooth; prosternum without fovea or punctures, the process bordered, glabrous; metepisterna hardly longer than wide, not much contracted behind. Protibial spur simple; mesotibiae ♂ inwardly slightly crenulate towards apex; metatibiae ♂ with a slight inner fringe of hairs on apical third; metafemora bisetose behind. Apical ventral segment ♂ with a single large pore on each side.

SIKKIM: Deutang, 1 ex. ♂.

The species is rather like *A. hypsela*, Andr., but the prothorax with blunt hind angles and shorter elytra. It does not fit into any of the existing palaearctic subgenera, but I hesitate, while so little is known of the Central Asiatic species in this genus, to propose a new one, especially on a single specimen.

***Amara alecto*, sp. nov.**

Length: 6 mm.

Piceous, shiny: joints 1 and 2 of antennae, lateral margins of prothorax, and tibiae more or less rufous.

Head smooth, of moderate size, frontal foveae lightly impressed, linear, clypeus transversely impressed rather than bordered, tooth of mentum not cleft, eyes not very prominent, with a single supraorbital seta on each side. *Prothorax* convex, about a third wider than head and as much wider than long, extremities truncate, base very little wider than apex, front angles only a little rounded, sides narrowly bordered and gently rounded in front, straight behind, without any trace of sinuation, hind angles obtuse, but fairly sharp, with the pore on each side just in front of them; median line and transverse impressions all very faint, only one basal fovea on each side, adjoining base and fairly deep, a slightly raised area between each fovea and side margin, on which one or two minute punctures can be seen, middle of base very finely longitudinally striate, surface otherwise nearly smooth and remarkably even. *Elytra* rather flat, ovate, a fourth wider than prothorax, and two-fifths longer than wide, sides rather strongly rounded, widest at about middle, shoulders finely and sharply dentate; striae moderately impressed and finely punctate, finer and shallower

near apex, scutellary striole short but distinct, no umbilicate pore, intervals a little convex, marginal series of pores widely interrupted, the pores very small. Prosternum ♂ without fovea, though one or two small pores are visible, the process bordered, bisetose (*i.e.* only two setae are now to be detected); metepisterna longer than wide, sulcate at sides, one or two punctures present, as also on sides of metasternum. Protibial spur simple; mesotibiae ♂ with three inner prominences on apical half; metatibiae ♂ without any inner fringe of hairs; metafemora bisetose behind. Venter slightly punctate at sides of base, last segment ♂ with a single pore and seta on each side.

TIBET: Kampa Dzong, 1 ex. ♂.

Not at all unlike *A. brucei*, Andr., but a little smaller, the prothorax with sharper hind angles, the elytra finely punctate, and differing also in more important characters.

Species are found occasionally both among the Pterostichini and Amarini in which, as here, the front supraorbital pore is missing. In 1894, Hor. Soc. Ent. Ross. 28 : 389 Tchitcherin discusses four species of *Amara* presenting this peculiarity, but they do not appear to form a homogeneous group and he does not suggest any new subgenus to include them. The affinities of the new species appear to be towards *Cumeres*, but there seem to be too many differences to allow of its inclusion in that subgenus.

***Pterostichus exochus*, sp. nov.**

Length : 13-14 mm. Width : 4.7-4.9 mm.

Black, rather shiny, palpi reddish.

Head small, frontal foveae short, deep, linear, diverging outwards behind, clypeus truncate in front, clypeal suture moderately deep, eyes fairly prominent, genae oblique, ligula bisetose, penultimate joint of labial palpi bisetose, mentum with a rather deep emargination, a central, rounded, longitudinal ridge, ending in front in a short, bifid tooth, a deep rounded fovea on each side of the ridge, antennae stout and with the basal joints cylindrical, extending a little beyond base of prothorax. *Prothorax* cordate, slightly convex, a half wider than head and a fourth wider than long, base bisinuate, its sides a little oblique, rather wider than apex, which is faintly emarginate, front angles quite inconspicuous, sides finely bordered, gently rounded, and sinuate near the angles behind, front seta at a third from apex, hind one on the angle, which is sharp and right; median line fairly deep, at least behind, though hardly reaching either extremity, transverse impressions obsolete, basal foveae deep, linear, parallel, not duplicated, surface smooth and remarkably even. *Elytra* moderately convex, oval, a little wider than prothorax, and two-thirds longer than wide, basal border entire, shoulders hardly dentate, sides very gently rounded, the widest point at or only just behind middle, border with only a suggestion of sinuation behind, the inner plica invisible; striae deep, impunctate, all reaching base, 7 with a pore near apex, scutellary striole reduced to an umbilicate pore adjoining the base of stria 2; intervals convex, 3 without any pore, 7 narrow and subcarinate on apical half, a short slight ridge near apex between interval 9 and margin, marginal series of pores widely spaced at middle. Microsculpture of elytra isodiametric and distinct; on the head and prothorax it is much finer and fainter, isodiametric on the former, moderately transverse on the latter. *Sterna* and *episterna* all more or less punctate, the prosternum along sides, the proepisterna along inner margin, the suture between them deeply impressed at base, prosternal process unbordered and glabrous; metepisterna only a little longer than wide. Venter more or less punctate at sides, the segments bisetose, apical segment ♂ with a single marginal seta on each side. Metafemora bisetose on hind margin; metatarsi with the basal joint outwardly sulcate, upper surface of all tarsal joints and under surface of joint 5 glabrous.

SIKKIM: Gangtok, 1 ex. ♂. A second ♂ specimen in my collection, also from Sikkim, is labelled "Pedong (*A. Desgodins*)" and was given to me some years ago by M. René Oberthür.

The absence of any dorsal pore indicates a connection with *Hypherpes* and *Abax*, the reduction of the scutellary striole to an umbilicate pore also points towards the former genus, while the short outer ridge near the apex of the elytra is similar to that in *Percus*. So far as I am aware all the palaearctic species of *Pterostichus* have at least one dorsal pore, but in the allied genus *Lesticus* this character is not allowed generic value, and I can see no reason at present why the new species described above, in spite of one or two rather unusual characters, should be excluded from the former genus. Bates described a solitary species of *Hypherpes*, viz. *H. colonus*, from Japan, but otherwise the genus is found only in North America, and in Leng's Catalogue it is merged in *Pterostichus*. I have compared the type of this new species with Bates' unique type, and find the two insects to be quite dissimilar.

NIRMALA, gen. nov.

Body winged. Head glabrous, eyes relatively distant from buccal fissure, two supra-orbital setae on each side, antennae pubescent from and including joint 4, labrum transverse, sexsetose, mandibles stout, strongly hooked and sharp at apex, without seta in the scrobe, ligula dilated at apex, bisetose, paraglossae very narrow, membranous, free, extending a little beyond ligula and separated from it rather widely, palpi with the apical joint truncate, about equal to penultimate in maxillaries, rather shorter in the labials, in which the penultimate is inwardly bisetose. Prothorax with its sides very widely explanate and bisetose. Elytra with a basal border, 9-striate and with a well-developed scutellary striole between stria 1 and suture, an inner plica interrupting the border behind, though it is hardly visible from above, no dorsal pores and no auxiliary striae or intervals near apex. Prosternal process glabrous, unbordered, not carinate behind. Protibiae moderately dilated; tarsal joints not sulcate, joint 5 with setae beneath, protarsi of ♂ with 3 dilated joints, clothed beneath with two rows of scales.

It will be seen that the genus is near *Pterostichus*, from which it differs widely in the form of the prothorax and also in the absence of any dorsal pore on the elytra. From *Abax* it differs much in appearance, and also in the absence of any auxiliary striae and intervals at the apex of the elytra.

GENOTYPE *Nirmala odelli*, Andr.

Nirmala odelli, sp. nov.

Length: 15-16 mm. Width: 5.2-5.6 mm.

Underside, legs, and antennae blue; palpi more or less piceous; head and prothorax bright metallic green, with some bluish reflections, chiefly in the lateral channels of the prothorax; elytra brilliant cupreous red, slightly sericeous, the base and lateral channels metallic green.

Head rather wide, frontal foveae nearly straight, not very deep, reaching mid-eye level, clypeus bisetose, emarginate in front, clypeal suture rather slight, surface impunctate, rather vaguely and irregularly striate in front and also at sides behind, eyes rather flat in the ♂, more prominent in the ♀, genae oblique and quite evident, antennae stout, reaching somewhat beyond base of prothorax, the joints all cylindrical, 1 stouter than the rest, about equal in length to 4 and the succeeding joints, 3 a third longer, 2 about half as long as 3. Prothorax rather flat, cordate, a half wider than head and as much wider than long, base truncate, apex slightly and widely emarginate, a little wider than base, front angles con-

spicuous, though well rounded, sides bordered, widely explanate and with a slight raised line running parallel with them, visible on each side on the explanate area, well rounded in front, sinuate near base, the front seta a little before middle, placed on the explanate area at some distance from margin, the hind seta on the angle, which is right, sharp, and deflexed; median line and front transverse impression both moderately deep, hind transverse impression very deep, basal foveae also deep, linear, joining the ends of the transverse depression on each side and thence directed obliquely forward along the inner margin of the explanate area, a boss on each side between the fovea and the hind angle, so that in effect there are two linear foveae on each side, the outer shallower than the inner one; surface impunctate, vaguely transversely striate, subrugose along base. *Elytra* rather flat, pointed at apex, not much wider than prothorax, fully twice as long as wide, the border forming a sharp angle at shoulder, slightly dilated behind to about three-fifths from base, the widest point; striae rather deep, impunctate but slightly and minutely crenulate, outer striae not quite reaching base, only 1, 2, and 7 reaching apex, a large setiferous pore near the inflexed margin on stria 7; intervals convex, surface a little irregular behind shoulder, where there is a slight impressed line on interval 7, the pores of the marginal series widely spaced at middle. Microsculpture isodiametric, conspicuous on elytra, extremely faint on head and prothorax. Underside smooth; metepisterna contracted behind, longer than wide. Ventral segments bisetose, apical segment with 1 seta ♂, 2 setae ♀ on each side. Metafemora bisetose on hind margin; dilated joints of the ♂ protarsi triangular, the basal joint strongly constricted at base and longer than wide.

I know of no other Carabid resembling this insect, but the brilliant contrasted colours of the upper surface, the widely explanate margins of the prothorax, and the absence of dorsal pores on the elytra will render it easy to identify.

SIKKIM: Karponang and Phadamchen, 1 ♀ ex. at each locality. Fortunately I have in my own collection a ♂ specimen from Maria Basti (*L. Durel*), also in Sikkim. This was presented to me some years ago by M. René Oberthür and I have made it the type.

LEPCHA, gen. nov.

Body apterous. *Head* glabrous, eyes flat, distant from buccal fissure, two very small supraorbital pores on each side, somewhat removed from eye, especially the hind one, antennae rather long, pubescent from joint 4, but joint 3 has some hairs at apex, labrum transverse, sexsetose, mandibles short and wide, hooked at apex, mentum with a fairly deep emargination, and a simple tooth almost as long as the lobes, ligula bisetose, truncate at apex, paraglossae narrow, membranous, free, extending somewhat beyond ligula, maxillae very sharp and hooked at apex, moderately fringed with bristles, apical joint of palpi subacuminate, truncate at apex, in the maxillaries half as long again as penultimate, the two joints about equal in the labials, the penultimate bisetose. *Prothorax* subquadrate, its sides bisetose. *Elytra* subovate, glabrous, base bordered, the lateral border uninterrupted behind (though a slight inner plica is present), 9-striate, without or with only the rudiment of a scutellary striae between stria 1 and suture, stria 8 very deep on apical half, interval 3 plurisetose. Prosternal process glabrous, not carinate behind; metepisterna as long as wide, hardly contracted behind. Venter smooth, the segments bisetose, apical segment with one marginal seta on each side in the ♂, two in the ♀. Metafemora bisetose on hind margin; protibiae gently dilated from base to apex; tarsi glabrous above, joint 4 slightly emarginate, joint 1 of metatarsi with a shallow outer groove, joint 5 slightly setulose beneath, protarsi ♂ with 3 dilated joints.

The genus is nearly allied to *Anchomenus*, but the eyes are unusually distant from the buccal fissure, the supraorbital pores are very small and the hind one

is placed at some distance from the hind margin of eye. In *Anchomenus* the form is graceful and slender, the palpi, antennae, and legs long and thin. The form of the two species for which this genus is proposed is short, wide, and compact, the antennae and legs stout, the latter also short.

GENOTYPE *Lepcha jelepa*, Andr.

***Lepcha jelepa*, sp. nov.**

Length : 4-4.5 mm.

Black, shiny, with vague traces of aeneous reflections : palpi (except basal half of apical joint), joint 1 of antennae, and tibiae ferruginous (but sometimes the femora and parts of the underside are also ferruginous).

Head rather large, convex, smooth, frontal foveae small but deep, extending on to clypeus, which is bisetose, clypeal suture obsolete, a small depressed area on each side surrounding the front supraorbital pore, eyes flat, antennae thick, extending beyond base of prothorax, the middle joints about a half longer than wide. *Prothorax* convex, smooth though somewhat uneven, two-fifths wider than head and as much wider than long, about equally contracted at extremities, though widest just before middle, sides finely bordered and gently rounded, nearly straight behind, front seta at widest point, hind one just in front of hind angles, which are obtuse, slightly rounded, and a little reflexed, the border—rather conspicuous at that point—rounding the angle and continued along base half way to middle; median line fairly deep between the transverse impressions, of which the front one is shallow, the hind one moderately deep, as are the basal foveae, between which and the angle there is on each side a slightly raised area of variable shape. *Elytra* smooth, but sometimes uneven, convex, nearly oval, a fourth wider than prothorax and fully a half longer than wide, shoulders inconspicuous, sides rounded, border near apex without trace of sinuation; striae very faint and with a suggestion of crenulation, 8 deep at extremities, shallow at middle, where the pores of the marginal series are widely spaced, scutellary striole obsolete; intervals flat, 3 with three pores, very irregularly placed, but generally at about one-fifth, two-fifths, and three-fifths, the first two at least adjoining stria 3. Microsculpture absent, though traces are just visible on head and prothorax.

I know of no other species nearly resembling this one and am unable therefore to make any comparison.

SIKKIM : Natang, 3 ex. TIBET : Jelep La, 2 ex. The Sikkim locality is sometimes written Gnatang or Gnatong.

***Lepcha lampira*, sp. nov.**

Length : 4.5 mm.

Black, shiny, and faintly iridescent : palpi (except basal half of apical joint), joints 1 and 2 of antennae, tibiae and tarsal joints (except at apex) more or less ferruginous.

Head convex, smooth, frontal foveae small but fairly deep, diverging behind and ending on each side at the front supraorbital pore, clypeus transversely depressed, bisetose, clypeal suture obsolete, eyes flat, antennae extending beyond base of prothorax, the middle joints three times as long as wide. *Prothorax* convex, smooth, fully a half wider than head, a third wider than long, widest before middle and contracted rather more in front than behind, so that base is a little wider than apex, sides finely bordered, strongly rounded in front, nearly straight behind, front seta at widest point, hind one well in front of hind angles, which are evident, though obtuse, rounded, and somewhat reflexed; median line deep just behind middle, shallow at extremities, transverse impressions visible at middle, front one faint, hind one fairly deep, sides of base depressed, a fairly large, rounded, raised area on each side, not extending to margins, and occupying the area near the hind angles. *Elytra* smooth, convex, nearly oval, about a third wider than prothorax and not quite a half

longer than wide, shoulders inconspicuous, sides well rounded, border practically without sinuation near apex; striae lightly impressed and finely punctate, 7 on apical half and the continuation of 4-5-6 near apex a little deeper than the other striae, 8 deep throughout, except for a short distance at middle, where the marginal series of pores is slightly interrupted, scutellary striole very fine and short, but visible; intervals nearly flat, 3 with four well-marked dorsal pores on right elytron, three on the left one, all adjoining stria 3. Microsculpture very fine, formed on the elytra by closely placed transverse lines, on the prothorax by very wide meshes, and on the head by isodiametric meshes.

Differing in many ways from *L. jelepa*; larger, the head relatively smaller, the joints of the antennae much longer, the prothorax more contracted in front, the elytra with clearly impressed and punctate striae, etc.

SIKKIM: Karponang, 1 ex. ♀.

***Taphoxenus brucei*, sp. nov.**

Length: 19-23 mm. Width: 6.75-7.25 mm.

Black, rather dull; palpi and joints 4 to 11 of the antennae piceous brown.

Body apterous. *Head* large, moderately convex, smooth behind, frontal foveae shallow, parallel, front slightly and irregularly striate, eyes flat, genae curving gently to neck, a little longer than eyes, mentum with a bifid tooth, antennae stout, extending a little beyond base of prothorax, joint 3 = 1 + 2, 4 and the succeeding joints about two-thirds of 3, pubescent from joint 4. *Prothorax* moderately convex, subcordate, a fourth wider than head, very little wider than long, widest at apical third, base and apex of equal width, both somewhat emarginate, front angles slightly advanced and not much rounded, sides bisetose, finely bordered and reflexed, well rounded near front angles, then nearly straight to base, moderately explanate and with a fine raised line a little removed from margin in front, the explanation widening out at basal third and stretching across base, hind angles obtuse and a little rounded, the hind seta in the angle; median line rather fine, front transverse impression wide and shallow, hind one forming the front of the basal explanation, basal foveae slight, containing about half a dozen punctures, surface of base uneven, disk with a few transverse striae. *Elytra* convex, oval, quite a third wider than prothorax, a half longer than wide, shoulders with an obtuse tooth, sides gently rounded, no appreciable sinuation behind; striae both very fine and very finely punctate, scutellary striole fairly long; intervals flat, no dorsal punctures, but two or three on interval 9 behind, marginal series uninterrupted, the pores numerous; surface smooth, dull, marginal channel uneven, with traces of fine pores. Microsculpture very distinct on the elytra, and formed by meshes which are rather longer than wide; on the head and prothorax the meshes are isodiametric, but very faint and only noticeable here and there. Underside smooth, metepisterna a little longer than wide, all ventral segments bisetose. Tarsal joints not sulcate, practically glabrous above, except joint 1 of the metatarsi, which is setulose; protarsi with all the joints similar at apex, and, apart from the lateral fringes of hairs, naked beneath.

Only one species of this genus, *T. brevipennis*, Sem., appears to have been described hitherto from Tibet; this is unknown to me in nature, but from the description it is evidently quite distinct from the new one. The latter is very similar to *T. dauricus*, Fisch., but differs as follows:—On the head the frontal foveae are longer and deeper, extending further back on to the front; the prothorax is more evidently explanate at sides, the front angles less rounded, the base much less deeply emarginate; on the elytra the basal border is less deeply emarginate on each side and the humeral tooth is smaller, the striae—though similar in depth—are less obviously punctate, and there is no umbilicate pore on each side near the origin of stria 1.

TIBET: Tinki Dzong, 1 ex.; Kyishong, 1 ex.; Shekar, 1 ex.; Tingri, 3 ex. All the examples are apparently ♀♀.

***Colpodes imitator*, sp. nov.**

Length: 6.5–7.5 mm. Width: 2.3–2.7 mm.

Piceous, shiny, elytra metallic green; base and apex of palpi, antennae, side margins of prothorax and elytra, apical margin, sutural interval, and epipleura of elytra, and legs ferruginous, but the femora infuscate towards apex.

Body winged. *Head* convex, smooth, neck deeply constricted, frontal foveae moderately deep, diverging behind, eyes fairly prominent, as long as genae, antennae slender, reaching basal third of elytra, pubescent from joint 4, which is a little shorter than 3, mentum with a simple tooth. *Prothorax* convex, small, a little wider than head and a little wider than long, base slightly arcuate, apex truncate, sides reflexed, evenly rounded, so that if the curve were completed the outline would be circular, hind angles quite rounded away, a seta on the margin indicating their site, front seta wanting; median line fine but distinct, front transverse impression shallow, hind one fairly deep, basal foveae deep and rounded, surface impunctate, with faint transverse striation on disk, basal area uneven. *Elytra* convex, not quite twice as wide as prothorax, a half longer than wide, dilated behind and widest at apical third, basal border nearly straight, shoulders narrow but evident, sides nearly straight to middle, then rounded to apex, practically without apical sinuation; striae strongly punctate, lightly impressed on disk, the outer striae formed by the punctures, which only disappear quite close to apex, scutellary striae short but very distinct, because the sutural interval is raised at that point; intervals faintly convex, 3 with three conspicuous pores, at a fifth, three-fifths, and fourth-fifths respectively. Microsculpture fine, consisting of transverse lines, which form fairly wide meshes on the prothorax and elytra, the meshes on the head isodiametric. On the underside the mes- and metepisterna, and the sides of the metasternum are punctate, the metepisterna nearly twice as long as wide, last ventral segment ♂ with two marginal setae on each side. Protibiae not sulcate, joint 1 of meso- and metatarsi with a faint external sulcus, joint 4 moderately bilobed, joint 5 slightly ciliate beneath near apex.

The above is a description of the type. The second specimen, taken at the same time, only differs from it in being larger and darker, the femora, tibiae, and the front half of the elytra piceous.

Apart from the tarsal characters, which are very different, the species bears a superficial resemblance to *C. semistriatus*, Chaud., being about the same size and similarly coloured. The neck constriction, however, is much deeper, the hind angles of the prothorax are rounded away, and the elytral striae are much more strongly punctate.

TIBET: Rongshar Valley, 2 ex. ♂♂.

***Colpodes shebbearei*, sp. nov.**

Length: 7 mm. Width: 2.4 mm.

Black, shiny: elytra aeneous, head and prothorax with faint aeneous reflections; palpi, antennae, tibiae, and tarsi ferruginous.

Head small, smooth, frontal foveae short, shallow, diverging behind, eyes small, moderately prominent, hind supraorbital pore far behind eye, antennae filiform, just reaching elytra. *Prothorax* convex, suboval, a third wider than head and about as long as wide, widest at middle, extremities truncate and of equal width, bordered, sides rather vaguely bordered behind, narrowly reflexed in front, a little more widely behind, without trace of lateral pores or setae, hind angles obtuse and rounded; median line fine, front transverse impression

rather faint, hind one wanting, basal foveae moderately deep, oblong, adjoining hind angles, surface practically smooth, vaguely rugose in the hind angles, a small rounded depression on each side of disk. *Elytra* convex, elongate-oval, the shoulders completely rounded away, a third wider than prothorax and a half longer than wide, widest at middle, sides rather strongly rounded, no sinuation behind, a very slight re-entrant angle at apex; striae fine but very clearly incised, minutely punctate, 1 and 2 arising in an umbilicate pore, a short scutellary striole present; intervals nearly flat, 3 without pores, except a large umbilicate pore close to apex, the large pores forming the marginal series practically uninterrupted. Microsculpture of prothorax and elytra consisting in very fine, closely placed, transverse lines, hardly forming distinct meshes, that of the head isodiametric. Metepisterna small, sulcate at sides, very slightly longer than wide. Apical ventral segment ♂ with a single marginal seta on each side. Protibiae with a faint external sulcus; meso- and metatarsi with at least joint 1 moderately bisulcate, the space between the sulci not carinate; protarsi with joint 4 bilobed, but in the meso- and metatarsi it is hardly more than deeply emarginate; tarsal joint 5 glabrous beneath.

The absence of lateral setae on the prothorax and of dorsal pores on the elytra, together with the complete rounding away of the shoulders, will render the species easy to determine. In Chaudoir's Monograph it would fall within the section headed by *C. ovipennis*, Chaud., but the four species included are all much larger and all come from South America. The only other Indian species I can recall without dorsal pores on the elytra is *C. impunctatus*, Andr., an insect which is not only much larger, but of quite different shape.

SIKKIM : Phadamchen, 1 ex. ♂.

Anchomenus praetor, sp. nov.

Length : 10.75 mm. Width : 4 mm.

Piceous, shiny; head and prothorax black, elytra dark blue; palpi, antennae, base of femora, tibiae, and tarsi more or less ferruginous; lateral margins of prothorax, apical margin of elytra, and metasternum vaguely brown.

Body winged. *Head* convex, smooth, neck moderately constricted, frontal foveae rather shallow, diverging vaguely towards eyes, which are flat and about as long as genae, palpi slender, antennae fairly stout, nearly reaching middle of elytra, pubescent from joint 4, which is as long as 3, mentum with a rounded tooth, the epilobes not projecting beyond the lobes. *Prothorax* cordate, rather flat, a third wider than head and a sixth wider than long, widest a little before middle, base with its sides a little oblique, hardly wider than apex, front angles rounded, sides bisetose, reflexed, unbordered, a little explanate, rounded in front and gently sinuate behind, the front seta in the marginal channel, the hind one just breaking the border on each side in front of the angles, which are reflexed, slightly obtuse, and not very sharp; median line and transverse impressions all distinct, though not deep, basal foveae fairly deep, continued forwards parallel with sides to rather beyond middle, a few minute scattered punctures along base and lateral channels, surface otherwise smooth. *Elytra* narrow and rather flat, not quite a half wider than prothorax, rather more than three-quarters longer than wide, widest behind middle, basal border slightly bisinuate, shoulders a good deal rounded, sides very gently rounded, and only faintly sinuate near apex; striae moderately deep, impunctate, 1 arising in an umbilicate pore, 8 deeper than the rest, scutellary striole fairly long; intervals slightly convex, 3 with three pores at a fourth, a half, and three-fourths, surface smooth. Microsculpture of the elytra and prothorax consisting in fine transverse lines, which form very wide meshes, distinct on the former, barely visible on the latter, the head with shallow, but quite visible isodiametric meshes. Underside smooth, metepisterna a half longer than wide, last ventral segment of ♀

with two marginal setae on each side. Protarsi with joint 4 moderately emarginate, meso- and metatarsal joints lightly bisulcate, joint 5 not ciliate beneath.

A little smaller than *A. complanatus*, Dej., but similar in form, though otherwise coloured. The surface throughout is much smoother, the genae less conspicuous, the elytra a little more convex, less deeply striate, the intervals consequently less convex, the sinuation at apex very slight, and the metepisterna longer. I know of no Indian species to which I can usefully compare this one.

SIKKIM : Darjeeling, 1 ex. ♀.

Anchomenus venator, sp. nov.

Length : 11 mm. Width : 4.5 mm.

Black, shiny, elytra with a very vague bluish-green tinge; joint 1 of antennae (rest brown), femora, and tibiae piceous; palpi and tarsi ferruginous.

Body apterous. *Head* convex, smooth, with a deep neck constriction, frontal foveae fairly deep, diverging behind, joined by a curved impression across front, a slight rounded impression on each side of vertex, eyes rather flat, genae conspicuous and much longer than eyes, palpi very slender, antennae rather stout, reaching basal third of elytra, pubescent from joint 4, which is barely shorter than 3, mentum with the tooth a little furrowed beneath and slightly bifid, epilobes wide, projecting on each side beyond the lobes as a small tooth. *Prothorax* convex, about a half wider than head and a fourth wider than long, base with its sides oblique, hardly wider than apex, which is emarginate, front angles rather rounded, sides bisetose, not bordered, a little reflexed and moderately explanate, rounded in front, then nearly straight to the hind angles, which are obtuse, reflexed, and somewhat rounded, the hind pore just breaking the outline in front of the angle; median line moderately deep between the transverse impressions, both of which are fairly deep, basal foveae large and deep, diverging in front, a few small scattered punctures in them, surface otherwise smooth. *Elytra* wide, convex, a half wider than prothorax and as much longer than wide, widest at about middle, basal border bisinuate, shoulders conspicuous though rounded, sides gently rounded, only a trace of sinuation near apex; striae rather shallow, impunctate, 1 arising in an umbilicate pore, 7 deeper close to apex, 8 somewhat deeper throughout, scutellary striae extremely short; intervals slightly convex, 3 with three pores at about a fourth, a half, and three-fourths, the front one adjoining stria 3, the two hind ones adjoining stria 2. Microsculpture of the elytra consisting in very fine transverse lines, which form very wide meshes, similar but fainter on the prothorax, the meshes on the head isodiametric but almost invisible. Underside smooth, metepisterna a little longer than wide, last ventral segment ♀ with 2 to 4 marginal setae on each side. Protarsi with joint 4 moderately emarginate, meso- and metatarsal joints bisulcate, joint 5 ciliate beneath.

A little like *Colpodes eulabes*, Bates, but wider and more stoutly built, the eyes not quite so flat, the prothorax wider and with the sides explanate from base to apex, the elytra more convex, widest at middle, with only a rudimentary striae.

TIBET : Tropde, 2 ex. ♀♀.

Anchomenus ambulator, sp. nov.

Length : 9-11 mm. Width : 3.5-4.1 mm.

Black, shiny, elytra dark blue : joint 1 of antennae and apical half of palpi piceous; joints 2 and 3 of antennae (rest fuscous), basal half of palpi, tibiae, and tarsi dark ferruginous.

Body apterous. *Head* convex, smooth, with a deep neck constriction, frontal foveae moderately deep, diverging behind, a rounded depression on each side of disk, eyes flat, genae conspicuous, curved, a little longer than eyes, palpi slender, antennae fairly stout reaching basal third of elytra, pubescent from joint 4, which is as long as 3, mentum with a wide bifid tooth. *Prothorax* convex, cordate, nearly a half wider than head, a fourth wider than long, widest a little in front of middle, base with its sides only slightly oblique, as wide as apex, sides with a slight border, a little reflexed and narrowly explanate, rounded in front and rather vaguely sinuate behind, the front seta placed in the marginal channel at the widest point, the hind one wanting, hind angles slightly obtuse, moderately sharp, and strongly reflexed; median line, transverse impressions, and basal foveae all fairly deep, the last named diverging in front, where there is a somewhat raised area between each of them and the lateral channel, surface uneven in the foveae, but smooth elsewhere. *Elytra* moderately convex, subovate, two-fifths wider than prothorax and rather more than a third longer than wide, widest a little behind middle, basal border slightly bisinuate, shoulders evident though somewhat rounded, sides gently rounded and only faintly sinuate near apex; striae moderately deep, outer ones at least with a trace of fine crenulation, 1 arising in a small umbilicate pore, 7 shallow on basal half, deep near apex, 8 fairly deep throughout, striae very short; intervals rather convex, 3 with three pores at about a fourth, a half, and three-fourths. Microsculpture of the elytra consisting of transverse lines so fine as to be almost invisible; that of the prothorax less fine but equally difficult to distinguish; that of the head formed by isodiametric meshes. Underside smooth, metepisterna a third longer than wide, apical ventral segment ♂ with 1 marginal seta, ♀ with 2 setae on each side. Joint 4 of the tarsi moderately emarginate, meso- and metatarsal joints bisulcate, the space between the sulci cariniform, joint 5 ciliate beneath.

Closely allied to *A. viridicans*, Andr., from Kumaon, but smaller and with blue elytra. On the head the neck constriction is deeper and the genae shorter and more curved; the prothorax is more contracted behind, the lateral margins less explanate and less reflexed; the elytra hardly differ in form, but have a much more evident microsculpture. In both species the tooth of the mentum is bifid and the hind setae of the sides of prothorax wanting.

SIKKIM: Natang, 1 ex.; Karponang, 2 ex. One of the examples from Karponang has a wider prothorax than the other two specimens, with its sides more widely explanate and more reflexed; as it agrees in other respects I treat it for the present as a variety.

***Anchomenus cursor*, sp. nov.**

Length: 9.5–10 mm. Width: 3.6–4 mm.

Black, shiny, elytra with a faint bluish-green tinge, subiridescent; palpi (except apex), joints 1 to 3 of antennae, and femora piceous; rest of antennae and legs, and apex of palpi dull ferruginous.

Body apterous. *Head* convex, smooth, with a deep neck constriction, frontal impressions short but fairly deep, a rounded impression on each side of vertex and sometimes a faint longitudinal sulcus in the middle, genae rather conspicuous, curved, and quite as long as eyes, antennae fairly stout, not quite reaching middle of elytra, pubescent from joint 4, which is hardly shorter than 3, mentum with a wide, bifid tooth. *Prothorax* convex, subcordate, nearly a half wider than head, a fourth wider than long, base with its sides a little oblique, rather wider than apex, widest before middle, sides bisetose, practically unbordered, reflexed, rounded in front, nearly straight behind, faintly sinuate just before base, front seta in the marginal channel, hind one just breaking the outline behind, hind angles slightly obtuse, reflexed, and fairly sharp; all the impressions fairly deep, the basal

foveae uneven at bottom and with a few minute punctures, surface otherwise smooth. *Elytra* fairly wide and rather flat, fully a half wider than prothorax, three-eighths longer than wide, widest a little behind middle, basal border slightly sinuate on each side, shoulders well marked, sides evenly rounded, with only a trace of sinuation behind; striae minutely crenulate, moderately impressed, shallow at sides, 1 arising in a small umbilicate pore, striole short; intervals slightly convex, 3 with three pores at about a fourth, a half, and four-fifths. Microsculpture of the elytra consisting in very fine transverse lines which hardly form meshes; on the prothorax the meshes are fairly wide, and on the head isodiametric. Underside smooth, metepisterna only a little longer than wide, last ventral segment ♂ with 1 marginal seta, ♀ with 2 setae on each side. Protarsi with joint 4 moderately emarginate, meso- and metatarsal joints rather vaguely bisulcate, joint 5 ciliate beneath.

About the size and shape of *Colpodes eulabes*, Bates; the eyes are more prominent, the prothorax wider at base, its sides more reflexed, the hind angles sharper, the elytra less deeply striate, especially at sides, the pores on interval 3 more conspicuous. The form of the fourth tarsal joint does not differ much in the two species, and both might be placed as appropriately in *Colpodes* as in *Anchomenus*.

SIKKIM: Karponang, 4 ex. A much damaged example was taken by Mr. H. Stevens at Nurbong "in bed of Sibakhola."

Anchomenus praedator, sp. nov.

Length: 9-11 mm. Width: 3.75-4.5 mm.

Black, shiny: apex of palpi ferruginous, vertex with a vague red spot on each side, elytra sometimes with a very faint metallic lustre.

Body apterous. *Head* wide, convex, smooth, with a slight neck constriction, frontal foveae deep, diverging behind, eyes rather large and prominent, antennae long and stout, pubescent from joint 4, which is equal to 3, palpi slender, tooth of mentum rounded at apex. *Prothorax* subcordate, moderately convex, a third wider than head and nearly a half wider than long, equally contracted at extremities but widest a little before middle, front angles rounded, sides with a narrow reflexed border, rounded in front, straight or faintly sinuate behind, front seta in the marginal channel, hind one on the border and breaking the outline just in front of the hind angles, which are obtuse, strongly reflexed, and very little rounded; median line rather fine, front transverse impression moderately deep, basal foveae large and deep, diverging in front, a slight rounded impression on each side of disk, surface smooth, basal foveae and lateral channels vaguely and minutely rugose-punctate. *Elytra* slightly convex, subquadrate, rather more than a third wider than prothorax, three-fifths longer than wide, basal border bisinuate, shoulders evident though rounded, sides very faintly rounded and sinuate before apex, where there is a slight re-entrant angle; striae fine, with traces of minute crenulation, a little fainter near apex, scutellary striole fairly long and deep, intervals flat, 3 with three large pores, front one adjoining stria 3, the two hind ones adjoining stria 2. Microsculpture isodiametric throughout, clear on elytra, barely visible on head and prothorax. Prosternal process unbordered; metepisterna fully a half longer than wide; apical ventral segment ♂ with 2, ♀ with 3 or 4 marginal setae on each side; protarsi with joint 4 moderately emarginate, meso- and metatarsal joints externally sulcate, joint 5 ciliate beneath.

There is no described Indian species resembling this one, and I therefore compare it with the very common Japanese *Anchomenus magnus*, Bates. The new species is much smaller, the head with rather deeper frontal impressions, the prothorax with more sharply rounded sides and a much shallower front trans-

verse impression, the elytra a little more convex, very much shorter, less sinuate at apex, and finely striate.

TIBET: Yatang, 1 ex. SIKKIM: Darjeeling, 2 ex.; Karponang, 7 ex.

The species appears to be a common one in the extreme north-east of India, and I have seen numerous examples in other collections, viz.:—(i) From Sikkim, (a) Gopaldhara, 3500 feet, and Mirik, 16 ex. taken by Mr. H. Stevens; (b) "Sikkim," 1 ex. in the Prague Museum (*Newton*); (c) "Sikkim," 5 ex. in the Deutsch. Ent. Museum; (d) Sureil (*A. Alcock*), 5000 feet, 1 ex.; Ghoom (*A. S. Kemp*), 7000 feet, 2 ex.; Pashok (*F. H. Gravely*), 5000 feet, 1 ex.; Sitong Ridge (*F. H. Gravely*), 4700 feet, 1 ex.; Kalimpong (*H. H. Mann*), 5500 feet, 3 ex., all in the Indian Museum, Calcutta; (e) an example in the Madrid Museum, without locality label, but almost certainly from Sikkim. (ii) From Assam, Shillong, 2 ex., taken by Prof. T. B. Fletcher and in the Pusa collection.

Anchomenus fur, sp. nov.

Length: 6.75–7.25 mm. Width: 2.5–2.75 mm.

Black, moderately shiny, elytra faintly iridescent, underside and femora (except at extremities) piceous; palpi, antennae, and rest of legs flavous; lateral margins of prothorax and elytra, with the epipleura of latter ferruginous.

Body apterous. *Head* very small, smooth, convex, without neck constriction, frontal foveae small and shallow, sometimes with one or two vague longitudinal striae outside them, eyes rather flat, palpi very slender, antennae also very slender, reaching basal third of elytra, pubescent from joint 4, which is longer than 3, tooth of mentum moderately sharp. *Prothorax* moderately convex, fully a half wider than head, a third wider than long, base with its sides very oblique, much wider than apex, which is emarginate, front angles very little rounded, sides finely bordered, a little reflexed, rounded to the hind angles, which are obtuse, reflexed, and rounded, the hind seta springing from a dilatation of the border just in front of them; median line fine, transverse impressions obsolete, basal foveae large, deep, and rounded, sometimes extending vaguely forward on each side to near middle of disk, surface smooth, basal foveae finely and very vaguely rugose-punctate. *Elytra* oval, rather flat, a half wider than prothorax, and as much longer than wide, basal border bisinuate, forming with the side border an obtuse angle at shoulder, only a trace of sinuation near apex; striae moderately deep, impunctate, a little deeper close to apex, scutellary striae short; intervals slightly convex, 3 with two pores (not always present), one at a fifth, adjoining stria 3, the other at three-fifths, adjoining stria 2. Microsculpture of the elytra consisting in very fine, closely placed, transverse lines, which form very wide meshes, similar but fainter on the prothorax, the meshes on the head isodiametric but very faint. Underside smooth, metepisterna hardly longer than wide, last ventral segment ♂ with one marginal seta, ♀ with two setae on each side. Protarsi with joint 4 moderately emarginate, the tarsal joints on all legs to some extent bisulcate, with a carina in the meso- and metatarsi between the sulci, joint 5 ciliate beneath.

There is no described Indian species at all nearly resembling this one. In the genus *Anchomenus* the elytra are nearly always more or less parallel-sided, but here they form a nearly regular elongate oval. The bisulcate protarsal joints, too, are very unusual, and these two characters taken together ought to render the species fairly easy to identify.

SIKKIM: Darjeeling, 7 ex. "Sikkim," 1 ex. in the Prague Museum.

APARUPA, gen. nov.

Body apterous. *Head* rather flat, eyes small, hemispherical, distant from buccal fissure, from 2 to 6 supraorbital setae, frontal foveae deep and uneven, antennae slender,

pubescent from and including joint 4, a circle of half a dozen setae round the apex of each joint, joint 2 about a half of the other joints, which are approximately equal in length, labrum transverse, sexsetose, clypeus bisetose, mandibles fairly long, hooked and very sharp at apex, right one with a tooth at middle, mentum emarginate, a deeply bifid tooth in the emargination, shorter than lobes, epilobes projecting on each side as a sharp tooth at apex of lobes, ligula fairly wide, bisetose, truncate, rounded, or even pointed at apex, paraglossae rather narrow, membranous, setulose, separated from ligula on each side by a fairly deep notch, curving inwards and extending some little way beyond it, maxillae hooked at apex, furnished fairly densely both with bristles and hairs, palpi slender, last joint subacuminate, not truncate, maxillaries with joint 3 a little shorter than 2 and 4, labials with 2 and 3 equal, 2 compressed and inwardly bisetose. *Prothorax* cordate, with at least 2, sometimes many lateral setae. *Elytra* with base bordered, 9-striate, a very short or rudimentary scutellary striole present, apical margin practically without sinuation or any external indication of the internal plica, which is nevertheless present. Prosternal process glabrous, unbordered, carinate behind. Venter with the segments bisetose, apical segment ♂ with one marginal seta, ♀ with two setae on each side. Tarsi slender, fringed with long hairs, their upper surface glabrous, joint 4 generally more or less bilobed, joint 5 glabrous beneath, protarsi ♂ with three joints dilated and clothed beneath with whitish scales, claws smooth.

GENOTYPE *Aparupa exophthalmica*, Andr.

The characters presented by this genus are very anomalous. The general facies, with the slender legs and antennae, suggest *Colpodes*, but the cleft tooth of the mentum and the internal plica of the elytra indicate relationship with *Pterostichus*, while the carinate prosternal process is rather like that of *Pristonychus*. The numerous supraorbital and prothoracic lateral setae in two of the species recall the genera *Chaetobrosceus* and *Amolops*, and the bulging eyes are similar to those of *Colpodes brunneus*, Macl., and *C. aeneipennis*, Dej. For the present I consider the genus as an aberrant form of the Anchomenini.

***Aparupa exophthalmica*, sp. nov.**

Length: 10.5–12 mm. Width: 4–4.25 mm.

Black, shiny, the elytra with vague greenish-blue reflections, sutural interval brown, underside piceous; palpi, antennae (joint 1 often darker), and legs ferruginous.

Head large, flat in front, convex behind, neck somewhat constricted, frontal foveae deep, uneven at bottom, extending on to clypeus, bounded outwardly by a curved ridge, outside which the side forms a raised carina above the first antennal joint, middle of clypeus and of front forming together a smooth raised boss, behind which is a transverse impression, sometimes shallow, sometimes deep, a further slight impression on each side of vertex, eyes very small, but so prominent as to be more than hemispherical, with two supraorbital setae, the hind one far behind eye-level, genae nearly twice as long as eyes and contracted very gradually to the neck constriction, ligula pointed in front, antennae not quite reaching middle of elytra. *Prothorax* moderately convex, a third wider than head and a fifth wider than long, widest before middle, base with its sides oblique, about equal to apex, front angles somewhat rounded but evident, sides bisetose, narrowly bordered and somewhat explanate, a raised line on the explanate portion in front, running parallel with margin, well rounded in front, straight behind, faintly sinuate before the hind angles, which are a little obtuse, rounded, and reflexed, the hind pore placed on the border and breaking the outline; median line and front transverse impression both fairly distinct, hind transverse impression and basal foveae deep, the latter long and linear, converging forwards from the angles and then diverging, disk smooth, with only some faint transverse striae, sides and to

some extent basal sulcus finely rugose-punctate. *Elytra* moderately convex, ovate, a little more than a half wider than prothorax and a little more than a third longer than wide, basal border straight and inconspicuous, shoulders and sides rounded, the apices separately and narrowly rounded; striae rather shallow but very clearly punctate, finer towards apex, 1 a little deeper than the rest, arising in an umbilicate pore, 7 deeper close to apex, and 8 deeper throughout, a very short scutellary striole present; intervals flat, 3 with two pores, just behind middle and not far from apex, adjoining stria 2. Microsculpture of the elytra consisting in very wide meshes, that of the prothorax similar but finer and fainter, that of the head isodiametric but almost invisible. Underside practically smooth, except mesepisterna, which are finely punctate; metepisterna small, sulcate at sides, nearly a half longer than wide. Protibiae without external sulcus; meso- and metatarsi with at least joint 1 externally sulcate, no internal sulcus; pro- and mesotarsi with joint 4 fairly deeply bilobed, but in the metatarsi only slightly emarginate.

SIKKIM : Karponang, 9 ex.

***Aparupa villosa*, sp. nov.**

Length : 9.5-10.5 mm. Width : 4-4.3 mm.

Black, shiny, head and prothorax with a very faint greenish tinge, elytra metallic green or greenish-blue, joint 1 of antennae and femora (except at base) piceous, palpi, joints 2 to 11 of antennae, tibiae, and tarsi ferruginous.

Head similar to that of *A. exophthalmica*, but the curved ridge bounding the foveae and the central boss are less developed, the neck constriction is comparatively deep, the genae are less inflated, straight instead of curved, there are half a dozen supraorbital setae, of which three are placed at some distance behind eye-level, and the ligula is slightly arcuate (convex forwards) in front. *Prothorax* very slightly narrower, base truncate, sides widely explanate, unbordered, each with about a dozen long setae, placed chiefly in front, on or close to the margins, the pores from which they spring conspicuous, sinuate both more deeply and further from the hind angles, which are right, sharp, and reflexed, the impressions similar. *Elytra* with the basal border bi-emarginate and conspicuous, the shoulders more evident, striae very faintly impressed and formed chiefly by the punctures, which are similar, 1 and 7 at apex no deeper than the rest, interval 3 with about six, 5 with three or four, and 7 with eight or nine large setiferous pores, 9 bearing the very irregular marginal series, adjoining stria 9, and with half a dozen pores on the interval, in addition to which there is a row of minute punctures in the marginal channel. Microsculpture wanting. Mesepisterna impunctate. Joint 1 of the meso- and metatarsi without external sulcus.

SIKKIM : Karponang, 7 ex.

***Aparupa beethami*, sp. nov.**

Length : 9-10 mm. Width : 3.7-3.9 mm.

Black, shiny, elytra dark aeneous; joint 1 of antennae and femora piceous; palpi, rest of antennae, tibiae, and tarsi ferruginous.

Head resembling that of *A. exophthalmica*, except that the ridges bounding the frontal foveae do not curve round so far in front, the clypeal suture is usually moderately deep instead of shallow, there are three or four supraorbital setae, of which the two or three hind ones are placed only just behind eye-level, and the ligula is truncate. *Prothorax* slightly wider, base faintly emarginate, a little narrower than apex, which is evidently emarginate, so that the front angles project forwards, sides narrowly bordered and widely explanate, with numerous long setae (as in *A. villosa*), placed in the marginal channel, less rounded in front, but more so behind, strongly sinuate at a sixth from base, the hind angles sharp,

acute, a little reflexed, and projecting laterally, the impressions similar, but the explanate margin is more conspicuously punctate. *Elytra* similar in shape, the striae with smaller and more numerous punctures, 1 hardly deeper than the rest, 7 only slightly impressed near apex, interval 3 with about half a dozen pores, 5 and 7 occasionally with one or two, 9 with some irregularly placed pores, and also with a row of minute punctures in the marginal channel. Microsculpture wanting. Episterna, sides of sterna, and sides of venter at base finely punctate. Joint 1 (and to some extent 2) of the meso- and metatarsi with both an external and internal shallow sulcus.

TIBET : Rongshar Valley, 5 ex.

***Brachinus hazardi*, sp. nov.**

Length : 8.5–9 mm.

Upperside black, underside piceous; mentum, palpi, joints 1 to 4 of antennae (rest brown), membranous apical margin of elytra, and legs more or less ferruginous.

Body winged, and covered with a fairly dense grey pubescence. *Head* with the frontal foveae moderately deep, wide, and subrugose, vertex nearly smooth, a patch of punctures on each side near eye, sides behind coarsely punctate, eyes fairly prominent, genae rather inconspicuous, last joint of palpi somewhat attenuated and truncate at apex, antennae long and stout, reaching middle of elytra. *Prothorax* practically as wide as head, very slightly wider than long, extremities faintly emarginate, base a little narrower than apex, sides gently rounded in front and sinuate at basal fourth, both front and hind angles slightly rounded, the latter projecting a little laterally; median line fine in the middle, deep at extremities, basal foveae moderately deep, surface rather finely and uniformly rugose-punctate. *Elytra* convex, nearly two and a half times as wide as prothorax, a half longer than wide, strongly contracted in front and widest a little behind middle, shoulders small but not rounded away, and projecting a little forwards, sides rounded, apex with a very distinct re-entrant angle, the membranous margin without setae, but with a fringe of minute hairs visible only under the microscope; striae without any rows of punctures, intervals moderately raised, subcostate at sides, the whole surface finely and fairly closely punctate. Microsculpture isodiametric and quite distinct on the elytra, invisible on head and prothorax. Prosternal process with a tuft of long hairs, metepisterna very long and narrow.

Like so many Eastern species, this one does not quite fit into any of the palaearctic subgenera, but it seems not very far removed from *Pseudaptinus*, though provided with wings and with the shoulders not quite rounded away. Although very much smaller, it is in form not unlike *B. italicus*, Dej., and has the same microscopic fringe of hairs on the membranous apical margin of the elytra. The prothorax is wider, much more rounded in front and more sinuate behind; apart from the less rounded shoulders, the elytra are very similar. I know of no nearly allied Indian species.

SIKKIM : Darjeeling, 1 ex. I have also seen four specimens taken by Mr. H. Stevens at Gopaldhara, 3500 feet, in the neighbouring Rungbong Valley.

***Cymindis hingstoni*, sp. nov.**

Length : 7–8.5 mm. Width : 2.5–3 mm.

Piceous, shiny : head vaguely red or with a reddish spot at middle; lateral margins of prothorax, lateral and apical margins of elytra, with epipleura and a shoulder-stripe on intervals 5 to 7 reaching to a third or a half (but sometimes reduced to a spot on shoulder, sometimes curving inwards and nearly reaching apex), palpi, antennae (light brown towards apex), legs, and middle of sterna and venter more or less ferruginous.

Head wide, moderately convex, frontal foveae rather shallow, eyes only moderately prominent, genae oblique and inconspicuous, antennae reaching basal third of elytra, apical joint of labial palpi ♂ only slightly dilated, surface practically smooth in the middle, rather sparsely punctate at sides. *Prothorax* moderately convex, cordate, slightly wider than head and about a third wider than long, base arcuate, not quite as wide as apex, sides narrowly reflexed, rounded, and sinuate just before hind angles, which are obtuse, reflexed, and project a little laterally; median line and front transverse impression distinct though rather shallow, basal foveae moderately deep, surface rather sparsely punctate, more closely on basal area. *Elytra* rather flat, subovate, nearly three-fourths wider than prothorax and a half longer than wide, basal border extending to the striae, apical truncature hardly apparent, a slight re-entrant angle at apex; striae moderately impressed and finely punctate, 1 and 2 arising in an umbilicate pore, scutellary striae very short; intervals nearly flat, surface moderately punctate and shortly pubescent, the punctures not forming any regular lines down the intervals. The elytra in the ♀ exhibit a microsculpture of isodiametric meshes, which is hardly visible in the ♂. The claws are minutely pectinate on the basal half only.

Though very much smaller, this species is not unlike *C. binotata*, Fisch., the colours being almost the same, but the pale margins of both prothorax and elytra are narrower, and the apical spots on the elytra are wanting; in addition the insect is a narrower one, and both prothorax and elytra are more contracted at base. There is also a fairly close resemblance to *C. longstaffi*, Andr., but that species is without the shoulder-stripe.

TIBET: Kampa Dzong, 2 ex.; Tinki Dzong, 1 ex.; Shekar, 1 ex.; Kyetrak, 15 ex.

Metabletus impar, sp. nov.

Length: 3.6–4 mm.

Piceous beneath, dark aeneous and shiny above: palpi, antennae, legs, border, basal fourth and apical fifth of elytra flavous. Considered as having a flavous background the elytra have a very broad dark band, which along the three first intervals extends forwards to base, and backwards very nearly to apex.

Head wide, smooth, frontal foveae short, but fairly deep, a slight depression on middle of front, eyes moderately prominent, mentum with a bifid tooth, ligula quadrisetose, paraglossae separately rounded at apex, adnate, extending a little beyond ligula, antennae slender, reaching basal third of elytra, joints 1 to 3 glabrous. *Prothorax* convex, a little wider than head, slightly more than a third wider than long, apex truncate, the front angles quite inconspicuous, sides narrowly bordered and reflexed, more widely behind, sharply rounded to apical fourth, where the front seta is situated and the border is subangulate, thence nearly semicircular in outline, the very obtuse hind angles just indicated, with a large pore on the border, and the middle of base slightly produced; median line clearly marked at middle, transverse impressions very faint, basal foveae evident but not very deep, surface smooth, with a few vague transverse striae. *Elytra* convex, ovate, two-thirds wider than prothorax, barely a third longer than wide, base emarginate, shoulders rounded though evident, rather strongly dilated behind and widest a little behind middle, sides well rounded, apex obliquely truncate and slightly emarginate on each side, exposing the last abdominal segment; striae very lightly impressed, with traces of puncturation, the area surrounding the scutellum depressed, a large umbilicate pore on each side of it, intervals nearly flat, 3 with two pores, practically on stria 3, at about two-fifths and three-fourths. Microsculpture isodiametric, conspicuous, rather coarse on prothorax and elytra, finer on the head.

SIKKIM: Darjeeling, 2 ex., found "under dead leaves."

I have put this species into the genus *Metabletus* with hesitation, both on

account of the form of the prothorax, and of the short, convex elytra. It agrees with that genus, however, in the presence of a tooth in the sinus of the mentum, in the glabrous third joint of the antennae, and the pectinate claws. Possibly a new genus may be required here, and, if so, it will include *M. monticola*, Andr. (and its var. *curtus*) from the Nilgiri Hills, the only species known to me, which, in its short oval form and the convexity of the elytra, at all resembles this one.

***Lebia aglaia*, sp. nov.**

Length : 5.5 mm.

Underside, palpi, antennae, and prothorax more or less ferruginous; head rather dark red; elytra black, the epipleura, front half of lateral borders, and two round spots on each elytron flavous. The front elytral spot is large and extends from stria 1 to stria 7; the hind one is smaller and extends from stria 1 to stria 5.

Head with rather shallow frontal foveae, a few fine longitudinal striae at sides, front and vertex finely punctate, eyes large and prominent, antennae reaching basal fifth of elytra. *Prothorax* convex, a fourth wider than head, and rather more than a half wider than long, middle of base moderately produced, apex emarginate, front angles rounded, sides bisetose, explanate, gently rounded from apex to base, hind angles obtuse, slightly rounded, and a little reflexed; median line rather fine, transverse impressions and basal foveae all clearly marked, surface finely punctate and with some vague transverse striation. *Elytra* slightly convex, three-fourths wider than prothorax, not quite a third longer than wide, base emarginate, depressed round scutellum, where there is a large umbilicate pore on each side, dilated behind and widest at two-fifths from apex, shoulders well marked, sides nearly straight up to the widest point, then rounded to apex, which is truncate, with the outer angles rounded; striae fairly deep, vaguely and minutely crenulate, intervals moderately convex, 3 with two pores at about a third and two-thirds, adjoining stria 3, and a large umbilicate pore on the interval quite close to apex. Microsculpture isodiametric and very distinct on elytra, absent on head and prothorax. Venter finely punctate and pubescent, last segment ♀ with two setae close together on each side. Claws with long pectinations.

The species will easily be recognised from its black, quadriguttate elytra : I know of no other Eastern species in which at least one of the pairs of spots is not in part marginal.

SIKKIM : Phadamchen, 1 ex. ♀; Lachen, 2 ex. ♀♀.

BRACHYPSECTRA, LEC.—THE SOLUTION OF AN
ENTOMOLOGICAL ENIGMA

By K. G. BLAIR, B.Sc.

[Read December 4th, 1929.]

PLATE I AND TWO TEXT-FIGURES.

IN 1905 Mr. H. S. Barber (1) described and figured a remarkable Coleopterous larva found in California under the bark of a dead tree-yucca. He was unable to place the larva in any family, and the identity and systematic position of the larva have ever since remained an unsolved entomological conundrum. The larva has, however, been found on various subsequent occasions and under somewhat different conditions, but all efforts to rear the beetle have failed. Professor G. F. Ferris (5) has recently given details of these occurrences, with a further figure of the larva, in the hope of eliciting information that would lead to the discovery of the identity of the beetle.

This latter figure was recognised by Mr. Ramachandra Rao as resembling some larvae found by him in S. India beneath the bark of tamarind trees, and from which the beetle was duly reared. Specimens of these were submitted to the Imperial Bureau of Entomology and to the British Museum for identification, but were found to be unknown in the National Collection; a single representative of a closely allied species from Singapore was placed, without determination, in the family DASCILLIDAE.

On further examination the beetle appeared to me to present certain Elaterid features, though it seemed impossible to place it in any known sub-family of the ELATERIDAE. An example was therefore sent to Mons. E. Fleutiaux for his opinion and was recognised by him as congeneric with *Brachypsectra fulva*, Lec., of Texas. M. Fleutiaux very kindly sent me for comparison his only specimen of that species, the genus not being represented in the British Museum, and expressed the opinion that the genus was correctly placed by Leconte and Horn (10) in the family DASCILLIDAE.

The identity of the larva figured by Barber, and again by Ferris, with the genus *Brachypsectra* would thus appear to be placed beyond doubt, and as its distribution would accord with that of *B. fulva*, Lec., the only known species of the genus, its specific identity is almost certain. There yet remain many points in its life-history upon which we know little or nothing. The nature of its food, for example, has yet to be ascertained. The mouth-parts are essentially of a predacious type, the sharp, strongly curved and channelled mandibles, no doubt serving to hold and at the same time suck the juices of living prey, are strongly reminiscent of those of the LAMPYRIDAE. Larvae were observed by Ferris to hold on one occasion a spider and on another a small Hymenopteron in their jaws, but they could not be induced to feed regularly, and all attempts to rear them were unsuccessful. Observations on a living larva sent by Dr. Ferris to Mr. E. E. Green and passed on to Mr. Hugh Main for rearing throw no further light on its feeding habits. On account of its suggested Lampyrid affinities it was provided with bits of cut-up snail, and certainly did remain with the front of the head in contact with the snail for hours at a time and appeared to increase slightly in bulk, but it may have

been the moisture that was acceptable to it rather than the nature of the food. This larva eventually died without change. As regards habitat, it is noteworthy that the larvae found by Barber and others were under dead bark or dead leaves, while others found by Ferris were in the cracks of rock. In the latter case there were abundant remains of hibernating insects, and it is possible that these, or perhaps the eggs of spiders or molluscs, form their natural prey rather than active creatures of any kind, the capture of which, owing to the extremely slow movements of the larva, would appear to be beyond its power. From its ability to withstand long fasts we may assume that such form a normal feature in its development, and this assumption, in conjunction with the remains of hibernating insects found in its haunts, is rather suggestive.

As regards the Indian larva, though it was successfully reared to maturity, we have unfortunately no details as to its habits. In structure it is remarkably similar to its American congener, though certain minor differences may be noted; the head, for example, is shorter and relatively broader; the enlarged second antennal joint is shorter and more pyriform, with the external apical angle enclosing the minute third joint more produced; the labial palpi are shorter, reaching only to the middle of the maxillary palpi, with their basal joint only as long as broad; the anterior lateral process of the prothorax is curved as in the American larva, but tapers gradually from the base, while in the latter it is strongly enlarged about the middle of its anterior side. With regard to the lateral fringed processes it may be noted that Barber describes them as two on each side of each thoracic segment and one on each abdominal segment. In reality there are in both species two processes on each side of each abdominal segment as well as on each thoracic, but the anterior lobe on the abdominal segments is very much reduced and scarcely visible unless the larva is well distended. In Mr. Green's photograph of *B. fulva* this lobe is well displayed.

The following generic diagnosis may be useful to supplement the brief statement of characters given by Leconte and Horn:—

***Brachypsectra*, Lec.**

Elongate-oval, depressed, pubescent, with rather soft integument. Head deflexed, deeply sunk in the prothorax; eyes large, prominent, entire, finely faceted; clypeus deflexed, constricted at base, its suture not evident; antennae stout, basal joint small, last 6 or 7 joints produced on inner side to form a fairly compact elongate club; labrum small, lying between the bases of the mandibles, the latter short and conical, apex acute slightly produced; labium transverse, concave; palpi small, last joint of maxillary palpi slender, acute at apex. Thorax transverse, truncate in front, strongly narrowed from base to apex, lateral carina sinuate, passing gradually into anterior border, invisible from above; scutellum subpentagonal. Elytra rather indefinitely striate-punctate, epipleura narrowing rather sharply behind base, evanescent some distance before apex. Wings present. Prosternum convex, with a narrow sub-buccal plate; coxal cavities transverse, angulate externally and widely open behind; posterior process moderately long, scarcely deflexed behind the coxae, received into a deep cavity in the mesosternum. Abdomen with five visible ventral segments, subequal in length, intercoxal process of the first short, obtusely angulate, 5th segment broadly rounded apically, the remainder withdrawn and concealed. Coxal sheaths of posterior legs gradually narrowed outwardly, extending behind the metepisterna. Tarsi simple, about as long as the tibiae, 1st to 4th joints of posterior tarsi gradually decreasing in length, the last joint about as long as the first; claws simple.

♂. Last 6 or 7 joints of the antennae produced on inner side into a broad cuneate lobe;

genital armature consisting of a median lobe (penis) and two lateral lobes (parameres), the latter sharply reflexed outwards at apex.

♀. Distal antennal joints much less strongly expanded.

***Brachypsectra lampyroides*, sp. n.**

♂. Elongate oval, flavous with the antennae, and frequently the elytra, darker. Head with an oval transverse depression between the eyes, rather strongly but not very closely punctate and pubescent; antennae with basal joint but little larger than the 2nd, 3rd joint elongate, as long as 1st and 2nd or 4th and 5th together, 6th to 10th expanded on inner side into a broad cuneate lobe, the last joint somewhat pyriform fitting against the lobe of the 10th. Thorax depressed across base, convex in front, anterior angles obtuse, posterior angles acute and divergent, dorsally carinate, the carina from above appearing lateral and concealing the true lateral carina; base triemarginate, the median emargination about half the width of the lateral; disc nitid, moderately densely punctate, each puncture emitting a rufous hair. Elytra punctured and pubescent much as the thorax, the punctures of the intervals similar to those of the striae, rendering these indistinct, sutural stria more distinctly impressed towards apex, the rest evanescent; the intervals somewhat convex; base carinate, the carina passing gradually into the lateral carina though concealed from above by the humeral callus. In some examples the apex of the elytra is bordered with fuscous. Length 5-6 mm.

♀. A little larger, the thorax more evenly convex along the middle line, more evenly semicircular in outline, the dorsal carina of the posterior angles not completely lateral, the elytra infusate almost to the base, and the antennae with only the last four joints expanded on the inner side, and that to a much less degree than in the male. Length 6-7 mm.

S. India: Coimbatore, 14.ii, 6.iii, 19.v.1916, reared from larvae found under tamarind bark (*R. Rao Coll.*).

Differs from *B. fulva* in the colour and structure of the antennae. In the American species these organs are fulvous, the 3rd joint but little longer than the 4th, and the 5th and following expanded. In *B. fulva* the elytral striae are more distinct, the intervals more finely and more sparsely punctate.

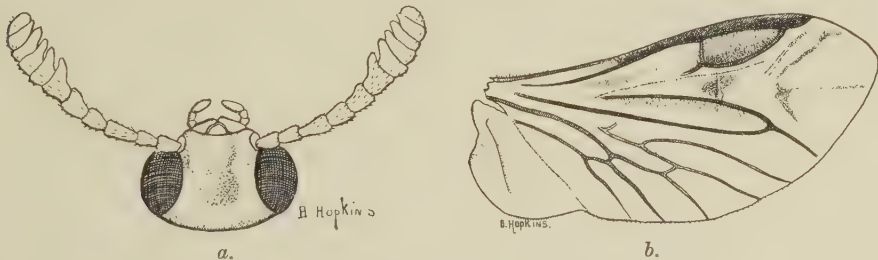


FIG. 1.—*B. lampyroides*, sp. n. a. Head of ♂. b. Wing.

***B. fuscula*, sp. n.**

Differs from the preceding in being reddish-brown in colour, the thorax a little lighter than the elytra. The head is wider, the width across the eyes about $\frac{2}{3}$ of the basal width of the thorax, the latter is therefore much less strongly narrowed from base to apex, the posterior angles are less acute and divergent, and the disc is more remotely punctate. In the expanded joints of the antennae the limb becomes wider transversely from the shaft to apex, its apical edge being nearly equal to the extreme width of the joint. In *H. lampyroides* this distal widening of the limb is present only to a slight degree. Length 6.5 mm.

Singapore. (*H. N. Ridley*): a single male example.

SYSTEMATIC POSITION OF *BRACHYPSECTRA*.

Leconte and Horn (10), though placing *Brachypsectra* in the family DASCILLIDAE, regarded it as sufficiently isolated to require a new subfamily for its reception. In certain structural features, notably the formation of the clypeus, the carinate posterior angles of the thorax, the prolonged prosternal process with a corresponding cavity in the mesosternum, the coxal sheaths of the posterior legs and the genital armature of the male, it closely approaches the ELATERIDAE or EUCNEMIDAE, but from both of these groups it differs in the exposed though small labrum, and in the form of the anterior coxae and their cavities, characters that indicate affinity with the DASCILLIDAE. The wing-neuration is also of an Elaterid type (*cf.* Kempers, 1923). With the CEROPHYTIDAE, a small family consisting only of the genus *Cerophytum* and occupying a position somewhat intermediate between the DASCILLIDAE and the ELATERIDAE, *Brachypsectra* has in common the constricted frons, the exposed labrum, the transverse anterior coxae of which the cavities are open behind and the strong prosternal process with the corresponding cavity in the mesosternum, but in *Cerophytum* the posterior coxae have no sheathing process, the mouth-parts are more developed, and the penultimate joint of the tarsi is expanded and villose beneath. Hence on the characters presented by the perfect insect *Brachypsectra* would appear to occupy a position intermediate between *Cerophytum* and the ELATERIDAE rather than between the former and the DASCILLIDAE.

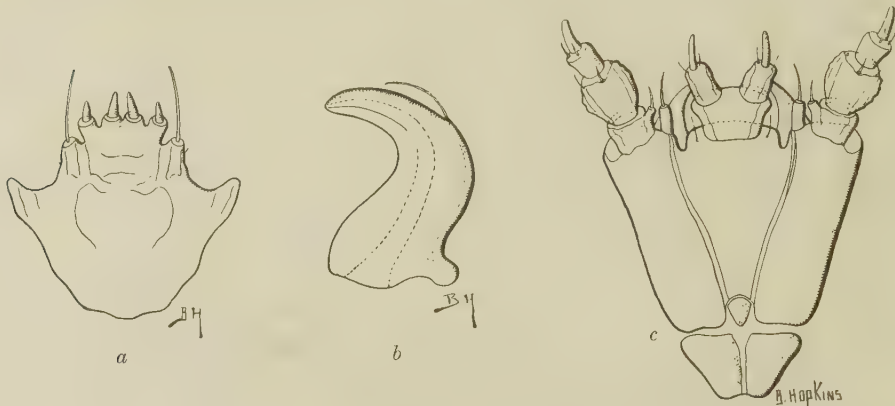


FIG. 2.—*B. lampyroides*, sp. n. Larva. a. Clypeus and labrum. b. Mandible. c. Labium and maxillae.

In these circumstances it might be expected that a knowledge of the larva would throw some light upon the question of the affinities of the genus. But the *Brachypsectra* larva would appear, like the adult, to occupy a very isolated position. To the caraboid larva of *Dascillus* (4, 6) it shows no resemblance. The aquatic larva of the CYPHONIDAE (11, 15) with its long, many-jointed antennae, seems at least equally remote; that of *Eucinetus* (13) shares the habit of living under bark, but shows no approach to the many peculiar features of *Brachypsectra*; neither does that of *Ptylodactyla* (12) nor that of *Cerophytum* (14). On the other hand, the fusion of the mentum with the bases of the maxillae to form a solid plate fitting into a deep emargination of the floor of the head, is very similar to the structure of these parts in the ELATERIDAE, while the somewhat digitate labrum, probably in this case a separate piece, strongly suggests the trifid "nasale" of the Elaterid larvae (7, 8).

On the whole, then, the evidence afforded by the larval characters supports the Elaterid affinities of the larva rather than any Dascillid relationship, but the larva differs so widely from any known Elaterid larva that wide separation is indicated. With the advance of knowledge it may become possible to bridge some of the existing gaps, and to include the genus as an aberrant member of one of the existing families, but for the present it seems impossible to regard it as other than a group of equal rank with *Cerophytum*, in other words to raise the subfamily formed for it to family rank as the BRACHYPSECTRIDAE, allied more closely to the ELATERIDAE than to the DASCILLIDAE.

The geographical distribution of this family, Texas and California, S. India and Malaya, is remarkable, but is perhaps not as yet completely known.

ANALOGOUS LARVAL FORMS.

The development of more or less similar frond-like lateral lobes along the body is found not only in the larvae of beetles of quite other families, but in insects of other orders also. It is no doubt connected with the habit of sitting close to the surface upon which the creature is resting, probably, in conjunction with the rather heavily armoured skin, as a protection against the attacks of ants. In the British Museum is an undetermined beetle larva from Borneo of similar form and with similarly formed lateral processes, but with very different head and the last segment having two terminal frondose processes similar to the lateral processes of the other segments. This is probably an Endomychid of some genus near *Eumorphus* (3). Many Ascalaphid larvae, some at least living on the bark of trees, also have a somewhat similar body form, but in this case the lateral lobes are simple, the fringes being formed of long narrow scales (16). In the aquatic larva of the beetle *Psephenoides gahani*, Champ. (2), broad lateral body lobes of a different type are found, designed in this case to withstand the rush of the rapid streams in which the larva lives clinging to the surface of stones.

Note.—Since the above was written I have received from Dr. Böving a copy of his remarkably illuminating paper "On the classification of Beetles according to larval characters" (*Bull. Brooklyn Ent. Soc.*, 24, 1929). This, however, deals with the other end of the Dascilloid series and its affinities with the Dryopoid series.

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EXPLANATION OF PLATE I.

- FIG. 1. *Brachypsectra fulva*, Lec. Larva. $\times 2$.
Photo. from life (H. Main).
2. *Brachypsectra fulva*, Lec. Larva. $\times 7$.
Photo. from Balsam mount (E. E. Green).
3. *B. lampyroides*, sp. n. Larva. $\times 7$.
Photo. from Balsam mount (E. E. Green).
4. *B. fulva*, Lec. Head and prothorax of larva.
5. *B. lampyroides*, sp. n. Head and prothorax of larva.
6. *B. lampyroides*, sp. n. Imago, ♂.

FIG. 5

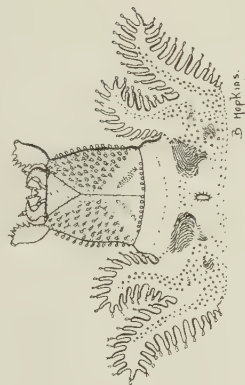


FIG. 6

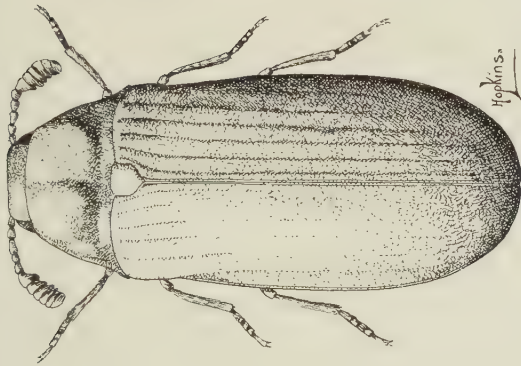


FIG. 4

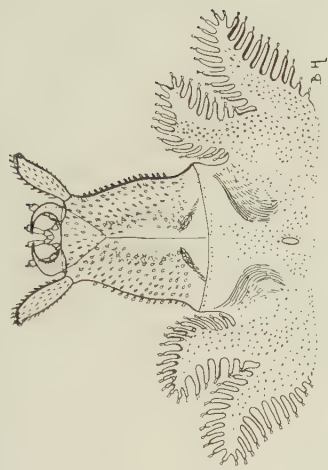


FIG. 3



FIG. 1

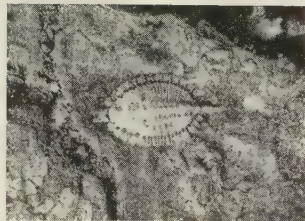


FIG. 2



BRACHYPTERID, LEC

OBSERVATIONS ON A MIGRATION OF BUTTERFLIES IN
VENEZUELA

By HAROLD E. BOX.

[Read February 5th, 1930.]

PLATES II, III, WITH ONE TEXT-FIGURE AND A MAP.

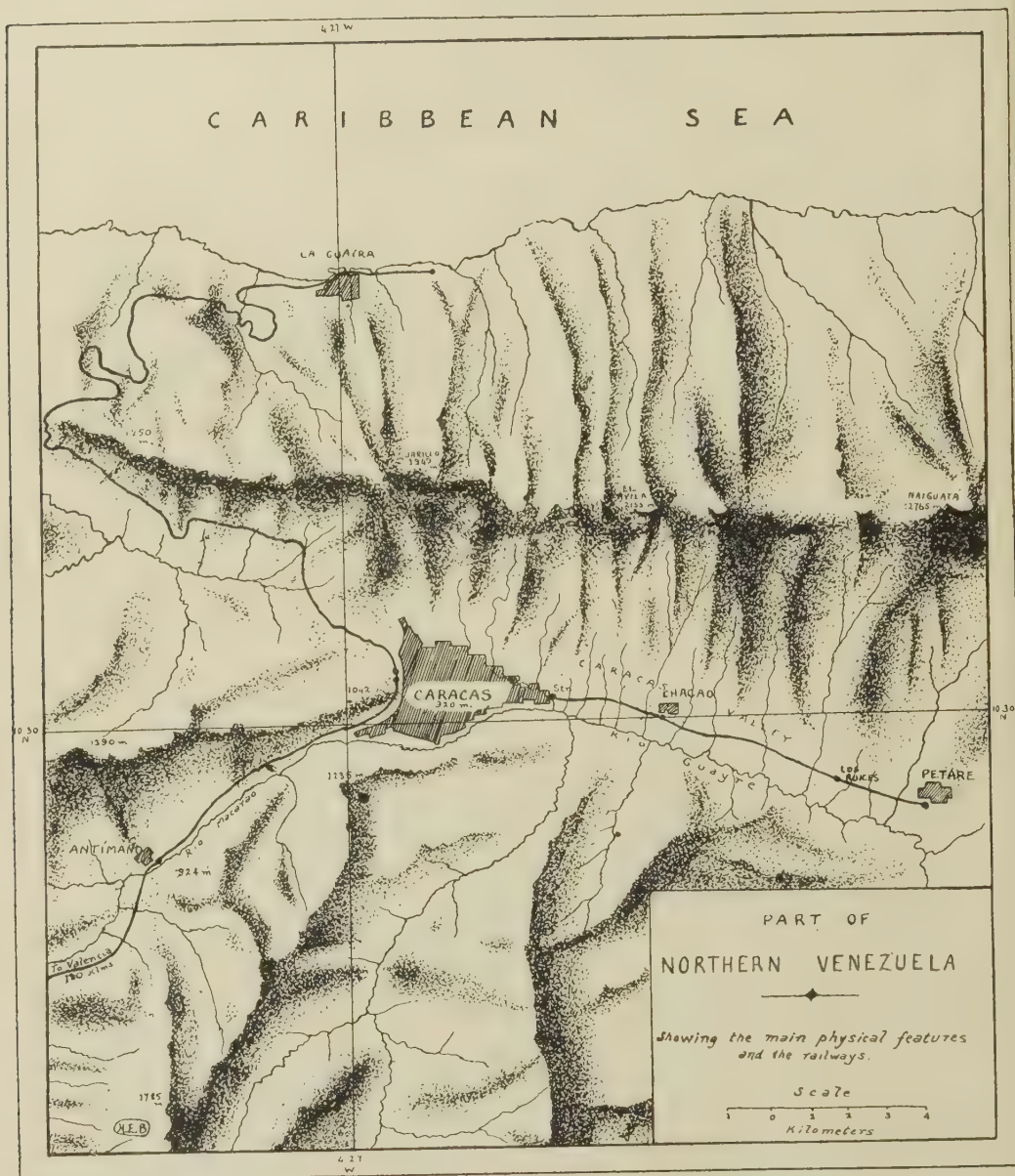
YELLOW butterflies of the family PIERIDAE are among the commonest of Venezuelan diurnal Lepidoptera, and several people whom I questioned informed me that migrations of them are not at all unusual, being of almost annual occurrence. It appears, however, from what I was able to gather from the accounts of eye-witnesses, and from the few semi-popular accounts which I came across in the Caracas Public Library, that the majority of these annual migrations are *away from* the country, the insects generally being observed in the region around La Guayra, on the north coast, steadily flying towards the east, in the direction of the island of Trinidad. I remember that in January, 1925, when travelling from Demerara to La Guayra *en route* for Porto Rico, in a steamer which kept quite close to the Venezuelan mainland, I saw what I now believe to be part of a migration of Catopsilias (and perhaps other Pierids as well). From as far east as Carúpano they were met with, flying a few metres above the level of the sea, and always in the opposite direction to that in which we were travelling, *i.e.* towards the east; at La Guayra they were seen in abundance in the streets. I paid very little attention to the matter at the time, and can supply no further details of the occurrence. I place the fact on record as it confirms the statements of others.

During 1926 I was stationed in Caracas while engaged in the search for parasites of noxious insects for introduction into Porto Rico, and in June of that year witnessed the migration of which the following is an account. I would mention here that at the time I was not well acquainted with the literature of the subject; hence the notes taken were simply those that occurred to me as being likely to prove of interest. Recently, however, Mr. Williams has very kindly sent me several of his important contributions to our knowledge of insect migrations, and from a study of his papers, and of one by Mr. L. D. Cleare, I have been able to amplify considerably the observations originally sketched in my field note-book, and in the following paragraphs I have endeavoured to supply every detail that may prove useful in analysing these only too meagre data. A good general idea of the type of country in which these observations were made can be secured by glancing at the photographs which illustrate this paper; a map of the district referred to will also be found. Mr. Williams emphasises the importance of accurate meteorological data when recording migrations of insects, therefore I have supplemented those noted at the time of the migration by reproducing (see Appendix) some of the published weather records of the Venezuelan national observatory at Caracas ("Observatorio Cajigal") for the years 1924 and 1925. I am informed that these years differed little from the normal for the locality, and that the year 1926 (for which most unfortunately I have no published records) was not marked by any special departures from the average. Caracas and its environs are noted for the stability of their climatic conditions.

On the morning of 25th June, 1926, yellow Pierids were more than usually

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abundant in the city of Caracas, though not sufficiently so to lead me to conclude that a migration was in progress, hence I made no attempt to collect either specimens or data, though later on I recollected that the insects were



for the most part flying "down town," i.e. from north to south. I also remembered that the children were catching the butterflies as they occasionally rested on the walls of houses or on the trunks of trees in the *plazas*, a fact which would seem to indicate that the insects were somewhat exhausted at the

time, for it has been my experience that butterflies of the genera *Catopsilia* and *Amyntia* (which I have generally referred to as "*Gonepteryx*" in my field notes) are far from easy to catch with the hand on warm sunny mornings; under normal (non-migratory) conditions, these Pierids are actively on the wing in the morning hours.

During the afternoon of the same day, however, it soon became evident to me that a migration of butterflies was taking place, so that I made every effort to secure information of possible interest, though, after glancing over Mr. Williams' rather formidable list of "data required,"* I fear this will be found very incomplete.

Having occasion to visit the canefields of the eastern section of the Valley of Caracas, I left the city at about 2 p.m. for the Central Railway station, with the object of taking the electric train which runs to the village of Petare, some eight kilometres distant. It was while I was waiting at the railway station that I first noticed the real abundance and the orderly flight of the butterflies. At the time there was a *very slight* easterly wind blowing, but the direction of the swarm was at right angles to the wind; the butterflies maintained their direction without any difficulty. It appeared as if they were coming straight from over the high Sierra del Avila, here less than two kilometres away, but rising to a height of nearly a thousand metres above my point of observation. After passing over some of the station outbuildings and the *patio*, the butterflies continued towards the eastern outskirts of the city.

I was able to estimate that approximately from 20 to 30 butterflies crossed per minute over a length of 10 metres at right angles to the direction of flight; their velocity could be easily estimated at about 7 or 8 kilometres an hour (slightly faster than a military marching pace). Specimens were collected, and though these were somewhat damaged and had a good many of their scales "rubbed off," I later sent them to the Imperial Bureau of Entomology; through the kindness of Sir Guy A. K. Marshall these specimens† were submitted to Mr. G. E. Bryant, who furnished the following determinations made at the British Museum:—

PIERIDAE: *Amyntia maerula*, Fabr.

Catopsilia sennae, L.

NYMPHALIDAE: *Eunica monima*, Cram.

Unfortunately, I made no attempt to calculate the percentage of the sexes among these butterflies, but regarding the relative abundance of the different species, I can state that the two Pierids were about equal in numbers, whilst the Nymphalid occurred at the rate of about one to every eight of the Pierids. The *Eunica* were in a far more damaged condition than either of the Pierids.

An observation worthy of note is that whilst both the *Amyntia* and the *Catopsilia* frequently interrupted their flight to rest upon wild vegetation or upon buildings, wood-piles, etc., the *Eunica* continued without resting at all, and during the entire period of my observations I never saw one of these Nymphalids at rest.

Also, it should be noted that whereas the Pierids flew quite low, not more than two or three metres from the ground (except for occasional individuals which flew much higher), the *Eunica* flew at a distance of certainly not less than $3\frac{1}{2}$ metres from the ground, and were correspondingly more difficult to catch. I confirmed this observation several times during the same afternoon.

* *Trans. Ent. Soc. Lond.*, 1923 : 230–231.

† Now in the Tring Museum.

The temperature at this time, as recorded by the station thermometer, was 28.5° C., the afternoon being rather hot for Caracas conditions, and decidedly hotter than the morning had been. There was every indication of a storm approaching, dark threatening clouds being banked up away to the east; between 2.0 and 2.45 p.m., however, the sky above was fairly clear, and the sun was shining brightly, as it had all the morning.

I was informed by the men in charge at the station that the butterflies had been noticed since the early hours of the morning, but not so abundantly as they were at the time I was there; they had not been seen the previous day. Nobody among those whom I questioned could remember having ever seen such a swarm of butterflies before, though smaller migrations of "yellow butterflies" were not unknown at this place.

At 2.45 p.m. I left in the train, and continued observing the flight of the butterflies. At Chacao, 2½ kilometres from Caracas, they were decidedly more abundant; I estimate that they passed at the rate of from 35 to 45 per minute over the length of the coach (about 12 metres), and rather faster than before, and it was noticeable that at this point very few of the Pierids rested, even for a moment. The same three species occurred here, and in about the same relative abundance as had been noted at Caracas twenty minutes earlier.

My journey terminated at a small wayside station called Los Ruices, about two kilometres from Petare. The country here is practically all under sugar-cane cultivation, though there are occasional small coffee plantations with plenty of wild vegetation. By the time I arrived at Los Ruices it was nearly 3.30 p.m. (trains travel slowly in Venezuela!); the former slight breeze had ceased and it had commenced to rain. At first nothing unusual was noticed; the butterflies were in abundance, though it seemed that the *Eunica* were more in evidence here. But by 4 o'clock, when the thunderstorm started and the rain took the form of a tropical downpour, a marked change took place in the hitherto slow migration of the butterflies. In the first place the two species of Pierids became apparently disorientated, and I desire to emphasise the facts I am about to record: this disorientation was at first among the butterflies *as individuals*; they seemed to lose all sense of direction and flew exactly as if caught in the eddies of a varying air current, though there was no wind at the time; they flew rather faster than when in "migration formation," but due to the fact that each individual would seldom sustain its direction for more than a dozen yards or so, I could do no more than hazard a guess of their velocity as being between 9 and 12 kilometres an hour. As before, some of them would stop awhile to rest upon the leaves of the sugar-canes, but they appeared very "restless" while resting, if I may be excused the paradox, continually shifting about and turning round. After a lapse of some ten minutes the butterflies seemed to be guided by what may be a sort of swarm instinct and gradually followed one another's movements, so that the disorientation occurred among them *as a mass*, the whole body of insects within sight moving now to the west, now to the east, and sometimes even doubling on their tracks and flying for a short distance to the north, but always together; these movements had something of a classical grace, and I shall always remember witnessing this phenomenon; the response to whatever tropism controlled their direction must have acted simultaneously among the insects to produce the singular effect I observed. All this time it was raining heavily and continuously, with thunder and lightning at frequent intervals; these conditions lasted for some twenty minutes, and by 4.30 p.m. the sky was completely overcast and the butterflies (*i.e.* the Pierids, for I saw very few *Eunica* at this

time, and these were all flying as if continuing their migration, an interesting point) were beginning to settle down, so that by 5 o'clock very few indeed of them were in flight, the majority being found resting quietly on the underside of the cane leaves, often three or four together, head to tail, after the manner of certain tropical Homoptera (FLATIDAE, MEMBRACIDAE, etc.); the few specimens that continued flying up to the time I left Los Ruices (5.35 p.m.) flew aimlessly about as if they had little or no volition of their own.

It should be stated that the temperature for the whole afternoon was fairly constant, and I estimate that it fluctuated between 28° and 29° C. between 2.0 and 5.30 p.m.; there must have been, however, considerable variations in both barometric pressure and atmospheric humidity during the same period.

As I returned to Caracas, the light was insufficient to enable me to see many metres distant and very few butterflies were seen in the fields along the track. There were, however, no less than 45 dead and damaged specimens in the railway-coach, but the conductor said there had been many more when he went away for his "*siesta*" after cleaning out the morning's accumulation.



FIG. 1.—Diagram (not to scale) of the Macarao Valley at a distance of a few hundred metres south-west of Antímamo, and looking towards Caracas. The distribution of the black dots indicates the relative abundance of yellow Pierids on the 26th and 27th June, 1926.

During the following days I saw no more of the *Eunica*, and the notes that follow refer entirely to the two species of PIERIDAE.

On the 26th June, yellow butterflies were again common in the city, always flying to the south. I was able to get out into the country in the afternoon, and at Antímamo (6 kilometres due south-west from Caracas) I noted the continued migration of *A. maerula* and *C. sennae*, again in about equal numbers. The insects were steadily flying up the Macarao Valley in the direction of Los Teques, but in far less numbers than when first observed; at this point the valley is extremely narrow, barely accommodating the river, railroad and concrete highway; the hills on either side are at an angle of nearly 40° degrees; the butterflies tended to keep to the eastern side of the valley, and were found up to the summit of the range of hills (here about 150–200 metres above the valley). Though most of those noted here were coming straight up the valley from Caracas, a good many crossed over the hills separating this valley from its neighbour to the east (see map, p. 52). A cross-section through the swarm here I have indicated diagrammatically in Fig. 1, which serves to show the distribution of the relative abundance of the butterflies.

Regarding meteorological conditions on the 27th June, I can only say that

the day was fine and sunny, and not too hot; the sky was clear except for low white clouds low down on the horizon.

There was no change in weather on the 28th, and on this day I again visited the Antímáno district and found the yellow Pierids still migrating to the south-west, though their numbers had appreciably diminished. The people of this region are quite familiar with swarms of yellow butterflies going "up the valley."

From inquiries I made later, I learned that during the 27th to the 30th of June "yellow butterflies were in unusual abundance in the vicinity of Valencia"; this town is roughly 150 kilometres west of Caracas, and, assuming the butterflies seen there were part of the migration observed by me on the 25th, their velocity would work out at about 4.33 kilometres an hour (allowing for 30 hours of flying time), which, taking into consideration their short but frequent resting periods, agrees fairly well with the velocity calculated from actual observations made at Caracas.

SUMMARY.

The basic results of the above observations may be summarised under the following headings suggested by Mr. Williams (*loc. cit.*):—

The locality of observation:—Venezuela: Caracas Valley; Macarao Valley.

The date or dates:—25th to 27th June, 1926.

The species concerned.^{*} *If more than one, their relative frequency*:—PIERIDAE: *Amyntia maerula*, F., *Catopsilia sennae*, L.; NYMPHALIDAE: *Eunica monima*, Cram. (See p. 53.)

The condition of the specimens:—(See Text.)

The approximate numbers of insects passing in a given time and in the whole flight:—Allowing for 40 hours of flying time, and a minimum average of 10 butterflies passing over a length of 10 metres per minutes, and estimating the total breadth of the flight as averaging 10 kilometres, there could not have been less than 24 million butterflies concerned in the migration. Actually the

^{*} My friend Mr. Rudolph Schreiter, Curator of the Natural History Museum of the University of Tucumán (Argentina), has very kindly supplied me with full extracts of all the references given to these species by Seitz ("Die amerikanischen Tagfalter," 1924). The following notes on distribution and nomenclature should be of interest:—

Catopsilia sennae, L. (= *yamana*, Reak.), is considered as a form of *C. eubule*, L. (= *marcellina*, Cram.), stated to be known from the New England States to Argentina, and also from the Antilles.

Gonepteryx maerula, F., is stated to range from Mexico to Southern Peru, but seem to be lacking from the eastern parts of these regions. The occurrence of the species in Venezuela is therefore rather interesting.

Eunica monima, Cr. (= *myrto*, Godt.). Seitz mentions the various "*Falterformen*" (*monima*, *modesta* and *pusilla*) which are considered by some authors as valid species, but which he believes to be all *monima*, which occurs in Florida, Mexico and Yucatan as well as in Cuba.

Whilst migrations of the two PIERIDAE do not seem to be unusual, that of the *Eunica* would seem to constitute a new record for the northern section of South America. It may be of interest to mention that Mr. Schreiter has personally observed a migration of *Eunica tatila*, H. Schöff, in Argentina, respecting which he states (Univ. Nac. de Tucumán, Mus. de Hist. Nat., (publicación) No. 9, 1926)—"*Eunica tatila*, H. Schöff.—One day in December of the year 1918 this Nymphalid appeared in Tucumán in numerous swarms. I cannot be sure of the fixed direction of their flight. Seitz' description in *Die Grossschmetterlinge der Erde* (p. 484) agrees with the specimens collected in this city. *E. tatila*, H. Schöff, which Seitz describes (*l.c.*), proceeds from Cuba, where, in certain years, this Nymphalid is present in enormous numbers of individuals: '... *tatila* ist nicht nur einer der verbreitetsten, sondern auch einer der gemeinsten Falter der Gattung, allerdings, wie die meisten *Eunica* nur jahrweise zahlreich auftretend.' Up to the present time, I have not observed other migrations of this species."

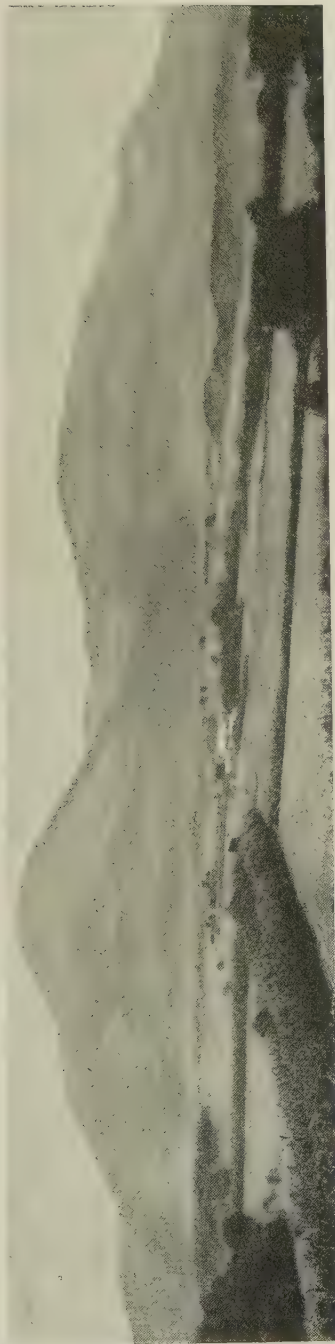


Fig. 1. The Valley of Caracas from near Los Ruices. Sierra "El Avila" in background.



Fig. 2. Caracas Valley : Electric railway at Los Ruices.



Fig. 3. Caracas Valley : The Peaks of Naiguatá.



Fig. 4. The Macarao Valley, looking towards and at a distance of about 1 kilometre from Antimano. (The arrow indicates roughly the position of the section shown in text fig. 1).

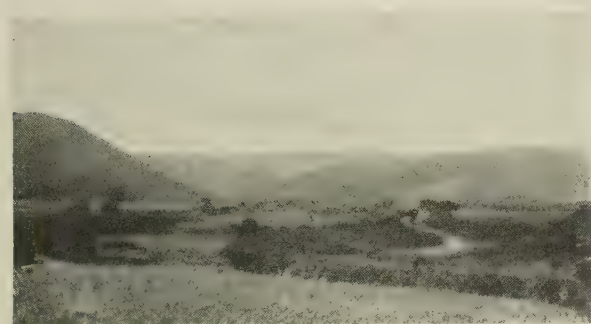


Fig. 5. The Macarao Valley, looking away from Antimano.



Fig. 7. The River Macarao at Antimano. (Plants in right foreground are *Gyncrium sagittatum*, Beauv.)



Fig. 6. The Great Western Railway of Venezuela: The Bridge over the River Macarao at Antimano in left background.

average number of specimens was very much higher on the first day, but 24 millions is the most conservative estimate of the total number of insects.

The proportion of the sexes concerned :—No data available.

The sexual development of the individuals :—The few specimens collected were all sexually mature.

The direction of flight :—From the north to the south, while in the Caracas Valley; later in a direction due south-west (at Antímáno).

The height and thickness of the flight. The speed of flight :—(See Text.)

The width of the flight :—On the 25th June the distance between the most easterly and the most westerly points where the butterflies were observed was $11\frac{1}{2}$ kilometres.

The time of the start and finish of the flight or flights :—(See Text.)

The condition of the sky :—(See Text.)

The relation of the date(s) to normal changes of season :—The weather was quite normal for the time of year (see Appendix). So far as I can remember the days of the migration were rather warmer than those previous had been.

The direction, force and constancy of the wind, and whether normal or abnormal :—An easterly wind of velocity of from 1 to 2 kilometres per hour is the normal for the locality during June; such a wind was blowing when the migration was first noted (? started), in the Caracas Valley. (See also Text.)

The temperature at the start and finish, whether normal or abnormal :—(See Text, and also Appendix.)

The electrical state of the atmosphere before and during flight :—(See Text.)

Recent rainfall and humidity, whether normal or abnormal :—No data available.

Any changes in direction of flight :—(See Text.)

Meteorological Map of the district :—Not available. Detailed weather records for Caracas, 1924 and 1925, are given in the Appendix.

Any tendency of the insects to follow . . . roads or contours :—Everything points to the butterflies having either originated on the southern slopes of the Sierra del Avila (to the north of the Caracas Valley) or else having crossed this mountain range from the coast. There was no evidence that they followed the series of valleys where the La Guayra-Caracas Railway and highway are located. When first seen they crossed the valley at right angles to its length, and were apparently content to follow the various valleys to the south; at Antímáno, there was a most decided tendency to follow the lower levels of the valley, which gradually rises to a culmination at Los Teques (more than 200 metres higher than the valley at Antímáno), then slopes again gradually to Lago Valencia. A study of the text and the map better illustrate this point.

Whether similar flights are known in the district :—(See Text.)

For those who might wish to give more study to the districts mentioned in this article, the following works, which are incorporated in the Society's Library, will prove of use :—

“Esbozo de las Formaciones vegetales de Venezuela . . . etc.” (“Outline of the Plant Formations of Venezuela . . . etc.”), by H. Pittier (with a supplementary Ecological Map by the same author). Caracas, Litografía del Comercio (1920).

“Esbozo de las Formaciones geológicas de Venezuela,” by Alfred Jahn (with maps, profiles and photographs). Caracas, Litografía del Comercio (1921).

Tucumán, Argentina,
12 March, 1929.

APPENDIX.

SUMMARY OF METEOROLOGICAL OBSERVATIONS. CARACAS, 1924 AND 1925.

From the Reports of the Cajigal Astronomical and Meteorological Observatory, Caracas (Longitude 4h. 27m. 43.3s. (Greenwich); Latitude 10° 30' 24.4" N.; Altitude above Sea-level 1042.5 metres).

TEMPERATURE AND RELATIVE HUMIDITY.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean
<i>Shade Temperature (° C.) :</i>													
Monthly Mean :													
1924	17.37	17.61	19.43	19.93	20.54	20.17	20.17	19.88	20.00	19.54	19.06	17.87	19.29
1925	16.78	17.41	17.75	20.65	21.40	20.29	20.22	19.97	20.05	20.19	19.88	19.46	19.50
Maximum extreme :													
1924	26.40	29.20	30.80	31.80	31.00	28.00	27.50	28.00	28.00	27.20	26.00	27.00	
1925	25.30	27.00	30.00	30.00	30.80	28.00	27.70	27.10	27.30	29.20	28.70	27.20	
Maximum mean :													
1924	24.03	25.54	28.05	28.12	28.22	26.28	25.65	25.48	25.29	24.81	24.34	23.45	25.77
1925	23.69	24.26	23.54	28.29	28.98	26.01	26.48	25.14	25.65	26.54	25.85	26.04	25.87
Minimum extreme :													
1924	9.40	9.60	11.80	12.00	12.90	14.00	14.40	14.00	13.90	13.90	11.90	9.40	
1925	8.90	9.40	10.10	15.40	14.40	14.40	14.00	14.50	14.50	14.40	13.40	11.00	
Minimum mean :													
1924	12.63	12.53	14.63	15.65	16.18	15.98	16.10	15.65	15.93	15.59	15.20	13.49	14.96
1925	11.89	12.18	13.40	16.42	17.02	16.68	16.31	16.21	15.96	16.15	15.94	14.65	15.23
<i>Relative Humidity (%) :</i>													
Maximum daily mean :													
1924	89.10	88.48	89.26	90.00	87.00	90.80	90.29	90.00	90.00	90.60	91.77	90.26	89.80
1925	88.42	89.00	89.16	89.97	89.45	90.23	86.51	90.16	89.67	89.61	90.67	89.03	89.57
Minimum daily mean :													
1924	57.00	51.59	46.42	48.00	49.00	55.87	58.61	58.00	61.00	65.90	66.87	64.00	56.85
1925	55.03	54.39	60.16	45.93	42.90	56.70	53.48	63.64	61.50	59.65	60.50	53.65	55.63
Monthly mean (average daily mean for the month) :													
1924	78.00	74.55	73.16	73.00	73.00	76.87	76.81	77.00	78.00	79.70	81.50	80.20	76.81
1925	75.26	76.21	76.84	72.43	71.13	75.43	73.19	76.97	77.37	76.55	77.77	72.29	75.12

WIND.

Direction:	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals
At 6 a.m. 1924 1925	E ¹³ , W ² E ² , W ¹	W ⁷ , E ¹ E ⁷ , W ⁶	E ⁷ , W ² W ¹ , E ¹	E ⁴ , W ² E ⁷ , W ¹	E ¹³ E ¹⁴	E ¹³ E ¹⁶	E ¹³ E ¹¹	E ¹⁰ E ¹⁶	E ¹⁵ E ³¹	E ⁸ , S ¹ E ³⁰ , SE ¹	E ¹⁴ , W ¹ E ¹³	E ¹⁴ , W ² E ¹⁴	E ¹³³ , W ¹⁷ , S ¹ E ¹³⁸ , W ³³ , SE ¹
At 12 noon 1924 1925	E ³⁴ , W ⁵ , SE ² E ³⁵ , SE ³	E ¹⁸ , W ⁹ , SE ¹ E ¹⁷ , W ¹¹	E ¹³ , W ¹³ , SE ¹ NW ¹ W ²⁵ , E ³	E ¹⁴ , W ¹⁴ E ¹⁵ , W ¹⁰	E ³⁰ , W ¹¹ E ³⁵ , W ⁴ , SE ¹	E ¹⁹ , SE ⁶ , W ² , SSSE ¹ E ³⁷ , W ³ , SE ¹	E ¹⁸ , SE ³ E ³⁶ , SE ⁴ , W ¹	E ³⁰ , W ¹ E ³⁷ , SE ³ , W ¹	E ³⁹ , W ¹ E ³⁵ , SE ² , W ²	E ¹⁸ , W ⁴ E ³⁷ , W ³ , SE ¹	E ³⁷ , W ³ E ³⁶ , W ² , SE ¹ , NW ¹	E ³⁴ , W ⁶ , SE ¹ E ³⁴ , SE ² , W ³	E ²⁶⁶ , W ⁷⁹ , SE ¹⁴ , NW ¹ , SSE ¹ , E ²⁷² , W ⁶³ , SE ¹⁷ , NW ¹
At 6 p.m. 1924 1925	E ³⁸ , W ⁷ , SE ² E ³⁵ , W ³ , SE ³	E ¹⁴ , W ¹³ W ¹⁷ , E ¹¹	W ¹ , E ¹⁰ W ²⁹ , SE ¹ , E ¹	W ¹⁴ , E ⁵ W ¹⁷ , E ¹¹	W ³¹ , E ⁶ , NW ¹ E ¹³ , W ¹⁰ , SE ³ , S ¹	E ¹⁴ , W ¹³ , S ¹ E ¹⁹ , W ¹⁰ , SE ¹	E ³⁴ , W ⁶ , SE ³ E ³¹ , SE ⁵ , W ⁴	E ³³ , W ⁹ E ¹⁹ , W ⁴ , SE ¹	E ³² , W ³ E ³⁰ , W ⁶ , NW ¹	E ¹⁵ , W ⁶ , SE ¹ E ³⁹ , W ⁶ , S ¹	E ³³ , W ³ E ³⁴ , W ³	E ³⁰ , W ¹¹ E ³¹ , W ⁶ , SE ³	E ¹⁵⁶ , W ¹³⁸ , SE ² , NW ¹ , S ¹ , E ²³⁰ , W ¹¹⁹ , SE ¹⁰ , S ² , NW ¹
At 12 night 1924 1925	E ³⁵ , W ³ E ³ , SE ⁴ , W ³	E ¹³ , W ⁹ W ¹³ , E ³	W ¹⁴ , E ¹⁰ W ¹⁸ , E ³	E ¹⁹ , SE ⁷ , W ² E ³¹ , W ⁴ , SE ³	E ¹⁹ , SE ⁶ , W ² E ¹⁶ , W ³ , SE ⁴ , ENE ¹	E ¹⁹ , SE ⁶ , W ² E ¹⁶ , W ³ , SE ⁴	E ¹⁴ , SE ⁶ , W ¹ E ³² , W ³ , SE ¹	E ¹⁸ , SE ⁴ , W ³ E ¹⁹ , SE ³ , W ³	E ³⁶ E ³⁴ , W ³ , SE ¹	E ¹⁷ , W ³ E ³⁴ , W ¹ , SE ¹	E ³⁴ , W ³ E ³⁴ , SE ¹ , ENE ¹	E ¹⁷ , W ¹⁰ E ¹⁸ , SE ⁴ , W ²	E ²¹⁰ , W ⁶⁵ , SE ¹² , E ²⁰⁹ , W ⁶⁴ , SE ²⁴ , ENE ²

NOTE:—The small numbers at the right of the letters (exponents) which indicate the direction of the winds, represent the number of times that these have blown.

WIND (continued) AND RAINFALL.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Wind (continued): Velocity, in kilometres per hour:												
Maximum:	3.8	5.3	4.7	3.8	2.3	2.5	2.3	2.4	2.3	3.9	2.5	2.6
1924	2.7	2.8	4.2	2.6	3.0	2.7	2.6	2.5	2.3	2.2	2.0	2.1
Mean:	1.53	2.16	2.66	1.78	1.60	1.71	1.62	1.55	1.52	1.76	1.65	1.56
1924	1.69	1.91	2.73	1.87	2.00	1.86	1.90	1.49	1.50	1.40	1.50	1.48
Rainfall:												
Quantity (mm.):	3.4	1.6	—	45.2	60.3	74.3	152.2	154.1	238.3	171.2	151.9	Total 1,060.5
1924	5.8	1.8	9.8	6.3	54.4	101.0	49.3	172.9	130.4	103.6	43.8	689.1
Duration during the month (hours, minutes):												
1924	5h, 11m	0h, 13m	—	9h, 14m	6h, 10m	24h, 30m	35h, 27m	25h, 23m	16h, 58m	20h, 15m	20h, 34m	158h, 09m
1925	7h, 55m	3h, 43m	5h, 23m	2h, 55m	2h, 40m	22h, 58m	7h, 56m	34h, 07m	17h, 63m	19h, 29m	9h, 24m	139h, 04m

THORACIC AND ELYTRAL ABNORMALITIES IN COLEOPTERA

- I. PROTHORACIC OUTGROWTHS AND ELYTRAL PROTUBERANCES.
 II. PARTIAL DOUBLING OF ELYTRON.

By E. A. COCKAYNE, D.M., F.R.C.P.

[Read February 5th, 1930.]

PLATES IV, V.

THE teratological Coleoptera described below have come into my possession or passed through my hands in the last few years. Those dealt with in the first part of the paper agree in having symmetrical or almost symmetrical abnormalities of the prothorax or elytra, and those described in the second part have partial doubling of one elytron. The *Lesticus janthinus* and the *Byctiscus populi* have remarkable prothoracic outgrowths and the *Hydrous bilineatus* has the prothorax divided by grooves into three lobes. For the *Lesticus* I am indebted to Mr. H. E. Andrewes and for the loan of the *Byctiscus* to Mr. L. G. Cox, to both of whom I wish to express my gratitude. The *Geotrupes vernalis*, the *Prosopocoelus*, the *Timarcha nicaeensis*, and the *Eurytrachelus purpurascens* have elytral protuberances unusual in their symmetry. For the identification of some of these beetles I wish to thank Mr. K. G. Blair and Mr. G. J. Arrow.

Byctiscus populi, L. Female. L. G. Cox. Bricket Wood. 19.ix.1926.

There are two nearly symmetrical lateral processes on the thorax, that on the left side being a little the larger. They are oblong and project downwards and inwards considerably beyond their attachments to the lateral aspect of the thorax. On the anterior surface of each there is a sharp sculptured ridge which curves inwards to the free lower extremity. The surface is smooth and polished with rows of punctures running in lines more or less in the long axis, but the punctation is not quite alike on the two processes, though agreeing in general arrangement. On Plate IV the first figure shows the dorsal view magnified by 20. Figures 2, 3 and 4 show the lateral and anterior aspects more highly magnified.

Lesticus janthinus, Dej. Tjibodas, Java. K. Kraepelin. 28.iii.1904.

The peculiarity of this Carabid consists in the fact that there are two almost symmetrical structures situated laterally on the prothorax. The side of the prothorax in normal specimens sweeps from before backwards in a smooth curve first with a large convexity and then with a smaller concavity outwards, and there is a flattened marginal flange with a rounded edge along its full length. In this abnormal individual there is a projection on each side at the point where the curve is becoming concave. The one on the right is the smaller and is a little posterior to that on the left. It forms a sort of shallow cup with a raised rounded rim slightly pitted externally. The whole of the cup is filled by a conical protuberance, which points upwards, outwards and a little forwards. The cone is blunt and, but for a few irregular shallow pits, is smooth and well formed. The projection on the left is larger but very similar in arrangement. Its rim is a little

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less regular and the shallow depression is bigger. The cone, which arises from its inner part does not entirely fill it, so that a little of the floor is visible to its outer side, and the cone points upwards and outwards. Its surface is rougher than that of the other cone. The ventral surfaces of the cups are smooth and polished. (Plate V, figs. 1, 3, 4).

Hydrous (Hydrophilus) bilineatus, Macleay. I. Z. Kannegieter. Telaga Bodas, Garoet, Preanger, Java. Jan. 1891. 4000-5000 ft.

The prothorax is divided into three lobes, each of the outer parts separated from the middle by a groove. There is a pit in the left groove and two smaller ones in the right, the pit on the left side being situated at a level slightly anterior to those on the right, and a fourth pit lies still further forward on the right lobe itself. Both the lateral lobes are raised and also project beneath as if the outer part of the prothorax on each side had been inflated.

The condition is almost exactly like that in the *Hydrobius fuscipes*, L., figured by Kraatz and described by Bateson, who says the prothorax is divided into three lobes, the two lateral ones a little smaller than the central. The lateral lobes appear to be smooth and are almost symmetrical. (Plate IV, fig. 8. $\times 3$.)

Geotrupes vernalis, L. Dresden.

On each elytron there is an almost hemispherical protuberance nearly 4 mm. in diameter, the anterior edge being about 5 mm. from the anterior end of the elytron and the outer edge reaching nearly as far as the outer margin of the elytron. The protuberances are exactly alike and symmetrically placed; their surfaces are smooth and highly polished instead of being punctate like the rest of the elytral surface. On the under surface there is a hollow corresponding with the prominence above, but the lower layer of membrane is not attached to the upper layer over this area and round its rim is thrown into a fold raised above the general surface of the elytron. The right elytron is a little shorter than the left and has a groove running across from the inner margin to the anterior edge of the protuberance. A depression, nearly oval, half of which is formed by the inner margin of each elytron, lies in front with its posterior end at the same level as the anterior edge of the protuberances. (Plate IV, fig. 5. $\times 2$.)

Prosopocoelus sp. near *forceps*, Voll. Female.

About the middle of each elytron is an elongate protuberance, the inner aspect of which reaches the inner margin of the elytron. Each protuberance is exactly the same size and shape, broader in front than behind and curving inwards posteriorly. Their surfaces are smooth and polished, not granular like the rest of the elytra. From the shoulder of each elytron there is a slightly raised ridge running at first parallel with the outer margin and then curving inwards to reach the protuberance near its anterior end. In front of each protuberance is a very slightly raised area occupying most of the space bounded in front by the base of the elytron, behind by the anterior end of the protuberance, and laterally by the inner border of the raised ridge and the inner margin of the elytron respectively. The protuberances resemble those figured by Asmuss in *Coccinella bipunctata*, L., but their symmetry is more perfect. (Plate IV, fig. 7. $\times 2$.)

Timarcha nicaeensis, Villa. Canialdo, Tuscany.

On the anterior part of each elytron there is a smooth oval prominence, that on the left 4 mm., and that on the right 3 mm. long. They are symmetrically placed and lie obliquely, the posterior ends inclining slightly inwards. The left elytron has four shallow grooves running inwards from the prominence. (Plate IV, fig. 6. $\times 3$.)

Eurytrachelus purpurascens, Vill. Male. Bat. Proepoe. 1.iv.1898.

There are two almost semicircular prominences symmetrically placed, one on each elytron; the straight side coincides with the outer margin of the elytron and there is a slight prolongation of the anterior end of each prominence along the margin. The prominences begin about 5 mm. from the base of the elytra, and that on the left side is 6 mm. long and that on the right 5 mm. long. The inner part of each elytron is rather flattened and marked with shallow transverse grooves. On the under surface of the elytron over the area occupied by the protuberance on the upper surface the thin lower layer of membrane is not adherent to the upper layer, but is thrown into folds and projects beneath the general surface. There can be little doubt that a blister containing fluid lay between the two layers and that after the fluid was absorbed the thin lower layer collapsed whilst the thick upper layer retained its shape. (Plate IV, fig. 9.)

In the CARABIDAE no prothoracic structures in any way resembling those of the *Lesticus* are found normally. In the CURCULIONIDAE *Platyrrhinus latirostris* has a small lobe arising from the middle of the prothorax on each side, that in some respects resembles the outgrowth in the *Byctiscus*, and the males of our British species of the genus *Byctiscus* itself have a sharp spine directed forwards and situated on the anterior part of the lateral aspect of the prothorax, but neither in shape, size, nor position does it show any similarity to the outgrowth on each side of the thorax of this abnormal specimen. The elaborate structure, symmetry, and in the case of the *Byctiscus* the large size, preclude the idea that they can be mere accidental outgrowths of chitin caused by injury. The most probable explanation is that they are mutations.

I know of no record of any abnormality in an insect that resembles them at all closely, though Schultze describes and figures an *Eristalis tenax*, L. (Dipt.), with a large bifid prominence arising from the middle of the dorsal part of the thorax, and Hustache describes and figures a *Phytonomus meles*, F. (Col.), with two tooth-like processes on the rostrum between the eyes and antennae, the antennae being symmetrically twisted and the scape compressed.

Mutations affecting the thorax have been recorded in *Drosophila*. One, called "comma," appeared in 1913 with a pair of chitinous thickenings on the anterior dorsal part of the prothorax. These thickenings were shaped like a pair of commas lying back to back, with their blunt tails pointing posteriorly, and depressed below the general surface. The mutant was an autosomal recessive and confined largely to females. Even in females it appeared in only twenty per cent, so that either it was very inviable or did not develop in every fly homozygous for the abnormality. A second mutant more like these beetles appeared in 1916 in a wild stock that had been caught in California and was called "vortex."

The abnormal flies had a pair of rosettes of microchaetae on the posterior part of the prothorax and at the centre of each rosette was a funnel penetrating more or less deeply into the thorax. Later Bridges found a female with an additional, but smaller, pair of rosettes on the anterior part of the prothorax and with the funnels in the centres of the posterior pair almost completely evaginated and horny, so that they resembled in shape volcanic cones with craters. In the offspring of this female the character was studied. The development of the vortex was very variable and was found to depend mainly on two recessive genes, one in the second chromosome and another in the third. Unless a fly was homozygous for the character in the second and at least heterozygous for that in the third chromosome the character never appeared, and only those homozygous for both had well-developed cones with

craters in the centre. Flies homozygous for the vortex character in the third and heterozygous for that in the second chromosome were always like wild flies in appearance. There were also two genes, one a dominant, that intensified the vortex character.

This discovery of a mutant in *Drosophila* behaving as a double recessive and causing the development of symmetrical prothoracic outgrowths makes it very probable that the outgrowths on the prothorax of the *Lesticus* and *Byctiscus* are of a similar kind. If, as in *Drosophila*, they are double recessives it would account for their extreme rarity, because the pairing necessary for their production must occur very seldom in unselected matings and even when it did occur would only produce them in a small proportion of the brood.

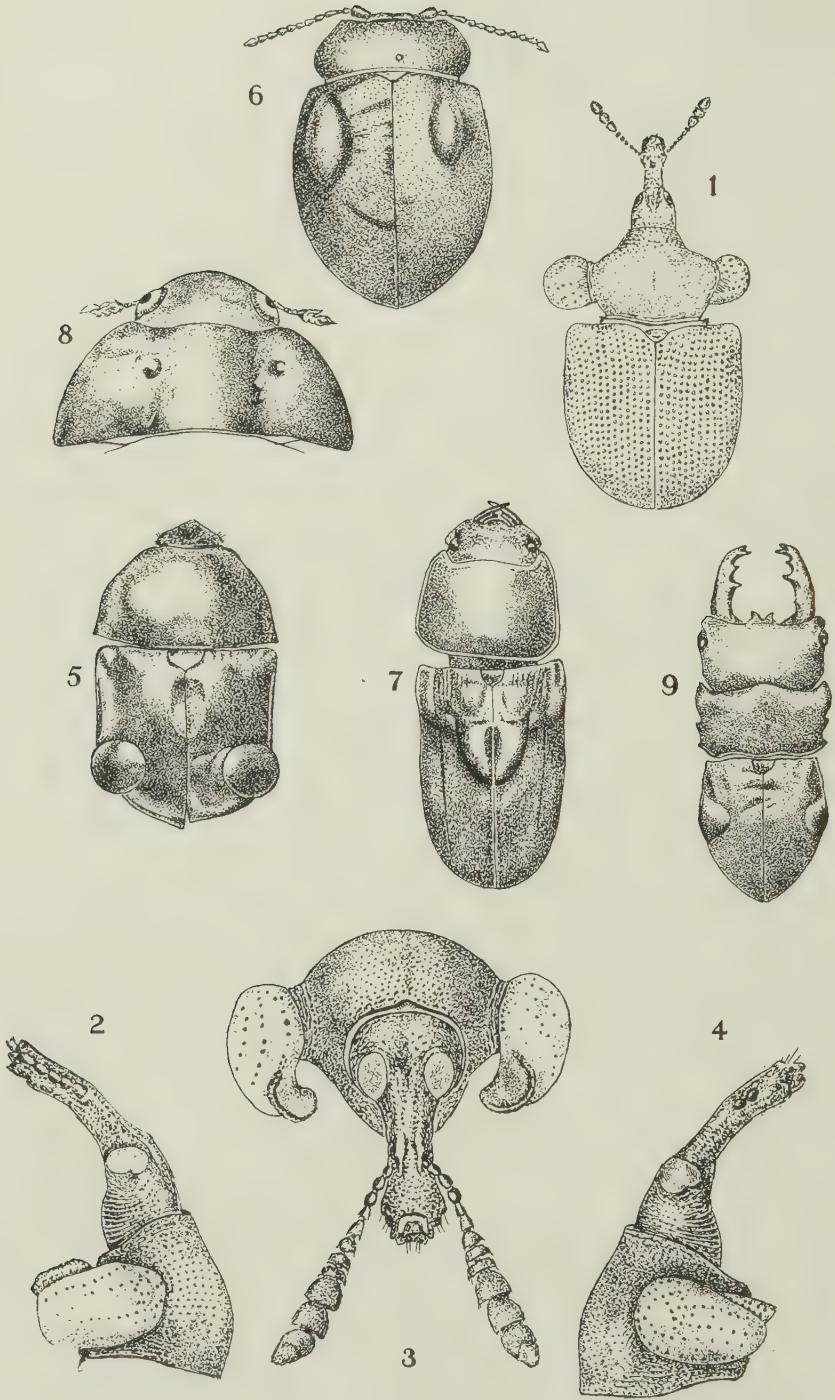
Mr. K. G. Blair thinks that the elytral prominences in the *Geotrupes*, the *Prosopocoelus*, the *Timarcha*, and the *Eurytrachelus* may be due to a separation of the two layers of membrane by fluid at a time when the chitin was soft. If so they would be comparable with the collections of fluid sometimes seen in recently emerged Lepidoptera and named aneurisms by Chapman. The smoothness of the prominences might be due to the stretching of the membrane with consequent obliteration of the normal punctures and striae. The condition found on the under surface of one elytron in the case of the *Geotrupes* and the *Eurytrachelus* makes it probable that Mr. Blair's surmise is correct. It is, however, difficult to believe that blisters so symmetrical could be due to an accident in the development of a normal insect, though in an insect, the subject of an inherited defect, such symmetry might be expected. Metz has described a sex-linked recessive mutant of *Drosophila virilis* with "vesiculated wings," in which there are usually two or three small blisters full of fluid near the centre of each wing. Sometimes there is a single one in this situation on each side, and occasionally the whole of each wing is converted into a bag of fluid as in the mutant, "balloon," of *Drosophila melanogaster*. The resemblance between these mutants and the abnormal beetles is too close to be disregarded.

Ancistrostoma farinosum, Sallé. Male.

There is a partial doubling of the right elytron. The inner elytron is complete with the usual three longitudinal lines of naked chitin, which unite near the apex; the outer elytron, the extra one, is very narrow and only completely separated from the inner one near the tip. It has one complete, but narrow, longitudinal line of naked chitin, and a second incomplete one which begins not far from the distal end of the elytron and joins the first in the usual manner near the tip. The double elytron is considerably wider than the normal single one, especially towards the distal extremity. Though it appears to be a case of simple duplicity, the extra elytron may be a fused double one.

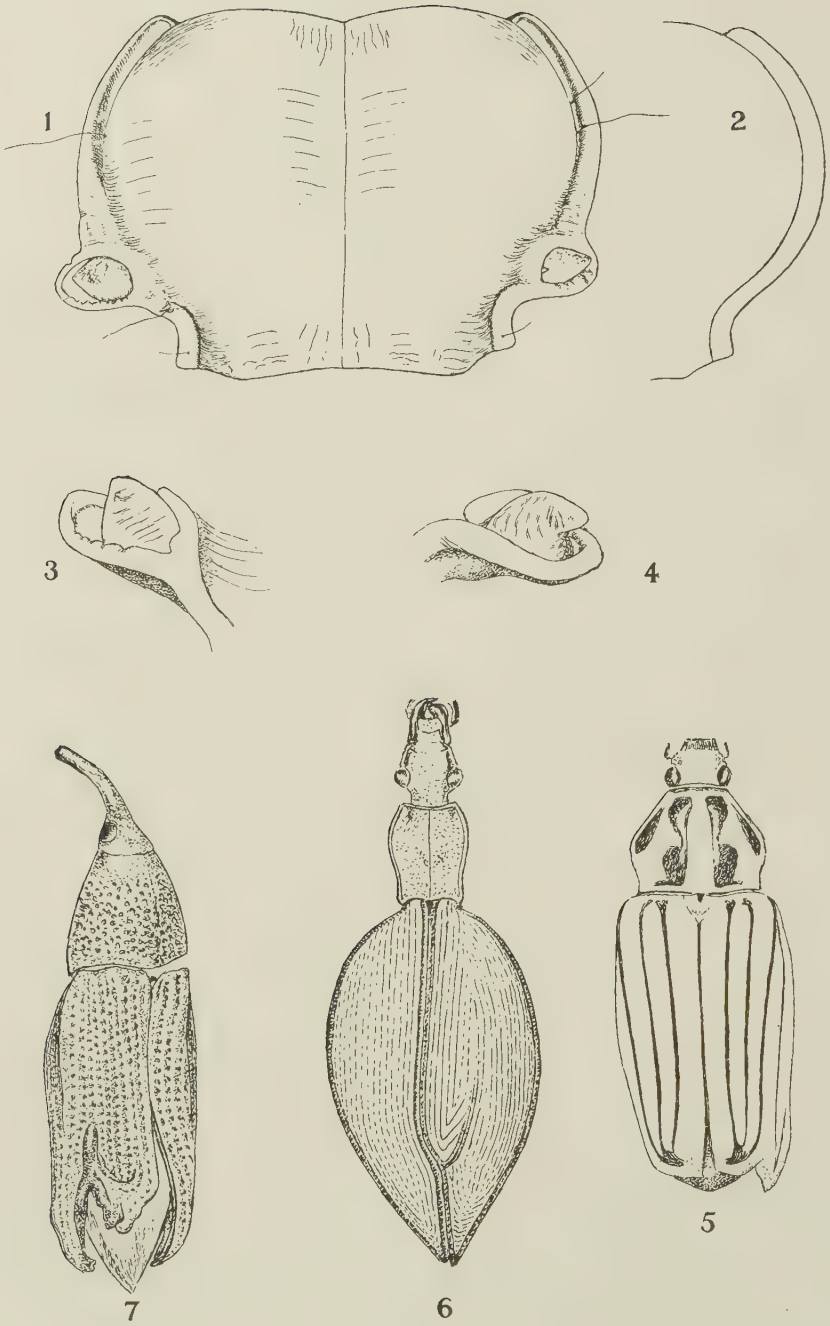
Carabus speciosus, Gerst.

There is partial doubling of the right elytron, which is a little longer and wider than the left; the inner margin of the abnormal elytron is bent upwards and inwards making it concave instead of straight near the junction of the proximal two-thirds with the distal third. The longitudinal striae are correspondingly distorted. The inner margin of the right elytron is bent upwards and outwards, so that it fits into the concavity on the inner margin of the left one. Where this outward curve ends the metallic purple thickened edge turns outwards and backwards towards the base and is obviously double, the inner portion forming the outer margin of one right elytron and the outer portion forming the inner margin of the other. About half-way along the elytron the double margin gradually fades away. The inner five striae run longitudinally, four starting from the base; the



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innermost ends blindly, but the other four form a series of loops one inside another by joining other striae, which start at various points, each successive one from within outwards beginning at a point more distal than the next. This part forms the inner of the two elytra on the right side. The outer has striae all of which are curved outwards, the outermost arising near the base, the inner ones springing from the same points as the outer ones of the other right elytron. These striae form a series of loops near the apex, resembling those near the apex of the normal elytron of the opposite side. This also appears to be an example of simple duplicity, but one or other of the incomplete elytra may be a fused double one. A very similar but more perfect example is described and figured by Frivaldsky in a specimen of *Megadontus azureus*, Dej. (Term. füsetek, 1887, 10, 80.)

Lixus vetula, F. Java.

The left elytron is deeply cleft posteriorly, and both the inner and outer portions show a terminal arrangement of puncturations like that of a normal elytron, but the whole elytron appears to have no more rows of puncturations nor to be appreciably wider than that of the opposite side. It may be an example of partial doubling or a mere partial separation of the elytron into two parts due to injury.

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EXPLANATION OF PLATES IV AND V

PLATE IV.

- FIG. 1. *Byctiscus populi*, L. Dorsal aspect. × 20.
 2 & 4. „ „ „ Lateral aspects. × 36.
 3. „ „ „ Anterior aspect. × 36.
 5. *Geotrupes vernalis*. × 2.
 6. *Timarcha nicaeensis*. × 3.
 7. *Prosopocoelus*, sp. × 2.
 8. *Hydrous bilineatus*. × 3.
 9. *Eurytrachelus purpurascens*. Natural size.

PLATE V.

- FIG. 1. *Lesticus janthinus*. Dorsal aspect of prothorax.
 2. Side of prothorax of normal specimen.
 3 & 4. Posterior aspect of processes more highly magnified.
 5. *Ancistrosoma farinosum*. × 3.
 6. *Carabus speciosus*. × 3.
 7. *Lixus vetula*. × 4.

SOME NEW AFRICAN AND INDO-AUSTRALIAN LYMANTRIIDAE
IN THE COLLECTION RECENTLY PRESENTED BY MR. JAMES
J. JOICEY TO THE BRITISH MUSEUM

By C. L. COLLENETTE.

[Read December 4th, 1929.]

PLATES VI, VII.

RIDGWAY'S *Color Standards and Color Nomenclature*, 1912, has been employed in the colour descriptions, and the Comstock-Needham system for the wing-neuration. Patagium = collar tippet, tegula = wing-base cover.

All types are in the British Museum collection.

I am greatly indebted to Mr. W. H. T. Tams for assistance rendered during the writing of the descriptions.

Sapelia barnsi, sp. nov.

♂. Palpus short, porrect, bone brown. Antennal shaft white, pectinations honey yellow. Head and thorax hairy, head deep chrome, tegula partially of the same colour, rest of thorax white. Abdomen white, with basal and terminal hair-tufts, the rest of the surface smoother. Fore-leg with inner surface black, outer surface white, rather long hair-tufts on the tibia, the process on the tibia tinged with deep chrome. Middle leg similar. Hind-leg white, streaked with black towards the distal end of femur and tibia, spurs black tipped. Wings semi-hyaline. Fore-wing white, very faintly tinged with ivory yellow; costal margin black from the base to a point midway between the discocellulars and the apex; two well-defined black spots, one at the upper angle and the other at the lower angle of the cell, with some sparse black hair-scales along the discocellulars; fringe ivory yellow. Hind-wing white; fringe white. Underside of both wings white, very faintly tinged with ivory yellow.

Expanse: ♂ 56 mm.

1 ♂ (holotype) and 2 ♂♂ (paratypes), Cubango-Cunene Watershed, South Central Angola, 5500 ft., October–November, 1928 (*T. A. Barns*).

The insect somewhat resembles *Sapelia tavetensis*, Holl., but can be distinguished from it by the considerably larger size and the greater extension towards the apex of the black margin to the costa of the fore-wing.

Porthmeia pyrozona, sp. n.

(Plate VI, fig. 2.)

♀. Palpus small and porrect, rich fuscous black. Antennal shaft drab; pectinations wide apart, fuscous. Head, thorax and abdomen rich fuscous black, anal tuft marguerite yellow above, whitish laterally. Legs rather sparsely scaled, fuscous. Pectus fuscous to fuscous black. Venter rich fuscous black. Fore-wing and fringe rich fuscous black; a broad oblique fascia of orange chrome across the medial area, its proximal edge commencing on the costa at about one-sixth and bowed (convexity apicad) to just before the tornus, its distal edge from the costa at slightly beyond the middle and bowed (concavity apicad) to the termen just above the tornus. Hind-wing and fringe rich fuscous black. Underside

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of both wings rich fuscous black, the orange-chrome medial fascia on the fore-wing considerably broader than on the upperside, occupying more than a third of the wing space and with its edges less deeply bowed.

Expanse: ♀♀ 41–43 mm.

1 ♀ (holotype) and 6 ♀♀ (paratypes), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 ft., November 1920–January 1921 (C., F., & J. Pratt).

This species agrees well with Bethune-Baker's description of the genus, excepting as regards the shape of the fore-wing, which in the new species is somewhat longer and more pointed at the apex than in the genotype *P. subnigra*, B.-Bak. (1908). The seven examples of *P. pyrozona*, however, show a certain amount of variation in this respect. In four of the paratypes the medial band of the fore-wing is coloured light orange yellow, which may be a natural variation rather than the result of fading.

Soreutoneura, gen. nov.

♂. Proboscis absent. Palpus short, porrect, the 3rd joint slightly shorter than the 2nd. Eye large, about the width of frons, round. Antenna bipectinate, the branches at middle about one-quarter the length of shaft, shortening towards both ends, each branch fringed with a row of short fine setae, and terminated with two bristles. Basal one-third of abdomen with a well-defined dorsal crest. Process on fore tibia nearly as long as the tibia, curved and bluntly ended. Mid tibia with one pair and hind tibia with two pairs of rather long spurs. Fore-wing with costa almost straight, termen and inner margin rounded, apex rather pointed, tornus rounded; anal vein simple at base, *Cu*2 from the cell at two-thirds, *Cu*1 from three-fourths the distance *Cu*2 to lower angle, *M*3 and *M*2 from lower angle, *M*1 from upper angle, *R*5 to *R*3 stalked, *R*5 arising just beyond the end of areole, *R*4 from about 2 mm. before the apex, *R*2 and *R*1 stalked, arising from cell about $\frac{1}{2}$ mm. before upper angle, *R*2 branching off and joining the stalk of *R*5 to *R*3, which is angled to meet it, about $\frac{1}{2}$ mm. beyond the angle, thus forming a short bar between the two stalks and completing the areole; in some specimens *R*1 approaches so closely to the stalk of *R*5 to *R*3 that the bar is not visible and there is an appearance of anastomosis; *R*2 anastomoses with the stalk of *R*5 to *R*3 for some distance, and leaves it at about 1 mm. beyond the end of the areole; *Sc* parallel with the costa. Hind-wing with costa almost straight, termen and inner margin rounded, apex rounded, anal angle much rounded; 3rd anal vein straight, 2nd anal slightly curved, *Cu*2 from the cell at three-fifths, *Cu*1 from three-quarters the distance *Cu*2 to lower angle, *M*3 from lower angle, *M*2 from slightly above lower angle, *M*1 and *Rs* on a stalk of about one-fourth, *Sc* anastomosing shortly with the cell at about one-half. Frenulum present.

Type *Soreutoneura daedala*, Collenette, sp. nov.

The arrangement of veins *R*2 and *R*1 in the fore-wing (veins 10 and 11 of Hampson's system) should be noted. The position of the genus is somewhat doubtful, but it has certain affinities in structure with *Euproctis*, Hbn.

Soreutoneura daedala, sp. n.

(Plate VI, fig. 9.)

♂. Palpus bone brown, the 3rd segment drab. Antenna honey yellow, the shaft somewhat lighter distally and with a tuft of amber-brown hair-scales at its base. Head bone brown. Thorax bone brown, the patagium edged posteriorly with amber brown, the

tegula composed of long, raised scales and hair-scales, bone brown proximally, amber brown medially and white distally. Abdomen cream buff, with an amber-brown dorsal crest on the basal segments. Pectus and venter light buff. Legs light buff, the fore coxa and femur with some long, bushy bone-brown hair-scales, the fore and mid tibiae and tarsi banded with bone brown and with some whitish hair-scales. Fore-wing medially, over more than two-thirds of the wing, with a general "brown" appearance, proximally and distally "yellow"; the basal and subbasal areas with some white on inner margin and at base, a curved streak of bone brown near the base of the cell, a patch of pinard yellow below the cell, and amber brown in the basal half of the cell and along the costa; medial area amber brown, darkening to bone brown in and below the distal half of the cell and towards the distal light area; below the anal vein some scattered scales of greyish lavender; a reniform spot of pinard yellow, with some whitish scales at its upper end; the division between the medial and distal areas is crenate, with concavities terminad and the points on the veins, while between the costa and vein *M*1, and also between veins *M*2 and *Cu*1, it projects considerably into the distal area; distal area maize yellow, suffused towards the termen with amber brown, and bordered with white proximally; a series of preterminal interneural whitish streaks, bordered distally with bone brown, parallel with the termen; fringe interneurally amber brown tipped with bone brown, maize yellow at the vein-ends. Hind-wing ivory yellow, fringe cream buff, towards the apex white lightly chequered interneurally with fuscous. Underside of fore-wing ivory yellow, beyond the cell tinged with cream buff, to warm buff apically; a patch of fuscous extending along the proximal two-thirds of the costa and descending to below the cell, where it merges into the ground-colour; a streak of ground-colour on the discocellulars; a further patch of fuscous in the subterminal area, extending from the costa to vein *Cu*1; fringe as on upperside. Underside of hind-wing ivory yellow; a spot of fuscous on the discocellulars and a curved mark of the same colour postmedially, from the costa to vein *M*2, with concavity basad; fringe as on upperside.

Expanse: ♂♂ 29–31 mm.

1 ♂ (holotype) and 17 ♂♂ (paratypes), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 ft., November 1920–January 1921 (*C., F., & J. Pratt*); also 8 ♂♂ (paratypes), Mt. Goliath, about 139° long., Central Dutch New Guinea, 5000–7000 ft., February 1911 (*A. S. Meek*).

***Euproctis hemicyclia*, sp. n.**

(Plate VII, fig. 8).

♂. Palpus short and porrect, light orange yellow, with some fuscous scales on the 2nd segment on the outer side. Antennal shaft cinnamon brown, grading to cartridge buff towards the tip (in some paratypes the whole of the shaft is light coloured); pectinations buckthorn brown. Head deep chrome. Thorax Brussels brown, the hair-scales of the tegula rather long. Abdomen and anal tuft deep chrome, basal segments Brussels brown. Pectus, venter and legs deep chrome, the tarsi somewhat paler. Fore-wing, with the exception of the costal, apical and terminal areas, russet irrorated with warm sepia to seal brown, the remainder of the wing primuline yellow; the boundary between the russet and yellow areas commences on the costa at one-fifth, thence oblique outwardly to below the upper margin of the cell, with which it runs parallel as far as the discocellulars, then, without reaching the costa, it describes a rough semicircle to vein *M*3, then outwardly oblique to below vein *Cu*1 and thence to the tornus; on the upper half of the discocellulars, and just within the yellow area, a conspicuous fuscous-black spot; between veins *M*1 and *M*2 another spot of the same size and colour, placed subterminally; three of the paratypes

exhibit a minute spot between veins *Cu1* and *Cu2*, situated in the yellow area and touching the russet area; two of the paratypes also exhibit a spot between veins *R4* and *R5*, placed subterminally; the last two spots are noteworthy as being present also in all the ♀♀ of the series; fringe primuline yellow. Hind-wing and fringe mustard yellow, lightly suffused over the proximal three-fourths with pinkish cinnamon. Underside of fore-wing mustard yellow to chamois; the dark area of the upperside reproduced below in fuscous, but obsolescent in the distal half of the cell and in the inner marginal area below vein *Cu2* and the lower edge of the cell; fringe mustard yellow. Underside of hind-wing and fringe, mustard yellow.

♀. Differs from the ♂ in the following points:—head apricot yellow; anal tuft velvety fuscous black; in the fore-wing the primuline yellow area descends at mid-cell to a point, just below the lower margin of the cell; the four fuscous-black spots referred to in the description of the ♂ are present and well defined; the hind-wing is suffused over the proximal three-fourths with fuscous; on the underside of the fore-wing the dark area is more strongly defined than in the ♂; in the allotype the hind-wing beneath is mustard yellow, but in the three paratype ♀♀ the fuscous of the upperside is reproduced below.

Expanse: ♂♂ 33–39 mm., ♀♀ 40–43 mm.

1 ♂ (holotype), 1 ♀ (allotype), 8 ♂♂ and 2 ♀♀ (paratypes), slopes of Mt. Korintji, S.W. Sumatra, 7300 ft., August–September 1921; also 1 ♀ (paratype), North Korintji Valley, 5000 ft., September–October 1921 (C., F., & J. Pratt).

Perhaps nearest to *Euproctis oreosaura*, Swinh. (1894), a ♀ of which was also taken by the Messrs. Pratt in North Korintji Valley.

***Euproctis amplior*, sp. n.**

(Plate VII, fig. 12.)

♂. Palpus Naples yellow, above and on the outside fuscous black. Antenna honey yellow, the shaft sparsely irrorated with fuscous. Head and thorax cadmium yellow. Abdomen fuscous black, cadmium yellow at the base, the anal tuft ochraceous tawny. Pectus, venter and legs Naples yellow to cadmium yellow. Fore-wing light cadmium, irrorated sparsely and evenly throughout with fuscous black; a fuscous-black spot at the centre of the discocellulars; an indistinct Mars yellow postmedial fascia, commencing just above vein *R5*, inwardly oblique and slightly bowed (concavity terminad) to vein *Cu1*, thence parallel with the termen to the inner margin; fringe light cadmium, and some long hair-scales of the same colour on the basal half of the inner margin. Hind-wing Naples yellow, tinged with light cadmium, the area between vein *Cu2* and the inner margin, on the basal three-fourths of the wing, fuscous; fringe apricot yellow. Underside of both wings Naples yellow, with a few scattered fuscous scales, especially along the costal margins and in the basal area of the hind-wing; the inner marginal area of the hind-wing fuscous as on the upperside; fringe Naples yellow.

Expanse: ♂♂ 45–52 mm.

1 ♂ (holotype) and 11 ♂♂ (paratypes), slopes of Mt. Korintji, S.W. Sumatra, 7300 ft., August–September 1921; and 6 ♂♂ (paratypes), North Korintji Valley, 5000 ft., September–October 1921 (C., F., & J. Pratt).

Allied to *Euproctis xanthomela*, Wlkr. (1862), from Sarawak and Malaya, but *E. amplior* is larger, the fore-wing much broader, the termen less oblique, and the fuscous area on the hind-wing considerably reduced.

Euproctis brunneipicta, sp. n.

(Plate VII, fig. 2.)

♀. Palpus, frons and legs snuff brown, mixed with cartridge buff and fuscous. Antenna drab. Thorax and vertex of head buff yellow, the patagium with some long backwardly directed hair-scales tipped with fuscous. Abdomen Sudan brown to auburn; anal tuft snuff brown, ringed at the base with cream buff. Fore-wing colonial buff, overlaid in varying degrees with buff-yellow; a basal patch of antique brown, its outer margin bowed, and reaching just beyond the junction of vein *Cu*2 with the cell; a broad postmedial fascia of antique brown to raw umber from the costa at two-thirds, oblique outwardly to vein *M*3, and inwardly oblique slightly bowed (concavity terminad) to the inner margin at three-fifths; from the postmedial fascia to the termen, excepting at the tornus and on the veins, the area is filled in with raw umber; fringe somewhat worn in the type, colonial buff mixed with raw umber. Hind-wing deep chrome, with a fuscous area on the inner margin which reaches from the base almost to the anal angle, its outer edge curving up to meet the lower margin of the cell at the origin of vein *Cu*2; fringe somewhat worn, buff yellow. Underside of both wings deep chrome, the fore-wing slightly less rich; apical area of fore-wing, from the costa at two-thirds to the tornus, raw umber; basal area of hind-wing, from the costa at one-third almost to the anal angle, raw umber; fringe of fore-wing raw umber, mixed towards the tornus with buff yellow; fringe of hind-wing buff yellow.

Expanse: ♀ 49 mm.

1 ♀ (holotype), Nomnagihé, 25 miles south of Wangaar, Dutch New Guinea, 2000 ft., January–February 1921 (*C., F., & J. Pratt*).

Euproctis aeana, sp. n.

(Plate VI, fig. 7.)

♀. Palpus, antenna, legs, thorax and abdomen blackish brown; anal tuft tawny, mixed with blackish brown laterally and ringed basally with warm buff. Fore-wing blackish brown; a broad whitish medial band from the costa, directed tornad, narrowing slightly throughout its length, and ceasing, with a slightly rounded end, just below the junction of vein *Cu*1 with the cell; fringe blackish brown, the hair-scales on the inner margin longer than those on the termen, but not developed extensively as in many other species of the genus. Hind-wing and fringe blackish brown. Underside of both wings blackish brown, the whitish medial band on the fore-wing broader than on the upperside and continued to the tornus, its distal edge, between veins *M*2 and *Cu*2, slightly excurved (convexity terminad).

Expanse: 54 mm.

1 ♀ (holotype), Central Ceram, 3000 ft., January–February 1920; and 1 ♀ (paratype), Manusela, Central Ceram, 6000 ft., October–December 1919 (*C., F., & J. Pratt*).

The holotype of *Diversosexus bicolor*, B.-Bak. (*Nov. Zool. Tring.*, **11**: 403, 1904), from Dinawa, British New Guinea, has been established by Lord Rothschild (*Nov. Zool. Tring.*, **27**: 324, 1920), as an *Elachyophthalma* (BOMBYCIDAE). The insect described as the allotype ♀ of *D. bicolor* is a *Euproctis*, and I propose for this ♀ (type in B.M.) the name *Euproctis bakeri*, **sp. nov.** This insect superficially resembles *Euproctis aeana* described above, but can be easily separated by reference to the original description. Among other differences may be mentioned the wedge shape of the whitish fascia, the presence of

long hair-scales in the basal half of the fore-wing, and the considerably shorter body.

***Euproctis mycoides*, sp. n.**

(Plate VI, figs. 4 and 5.)

♂. Palpus Brussels brown tipped with cinnamon-buff. Antennal shaft cinnamon buff, the basal segment cartridge buff; pectinations honey yellow. Head buckthorn brown. Thorax antique brown, with a few long upright cartridge buff hair-scales. Abdomen Brussels brown, heavily irrorated on basal segments with cartridge buff; anal tuft snuff brown, ringed at the base with cartridge buff. Legs and pectus antique brown to snuff brown, streaked with cartridge buff. Fore-wing with basal portion rich Brussels brown to antique brown, the distal boundary of this area commencing on costa at one-third, bowed (convexity terminad) to anal vein, and outwardly oblique to inner margin; a few long cartridge buff hair-scales scattered in and below the cell; medial area with costal margin whitish to a depth of 2 mm., then snuff brown to inner margin; a Brussels-brown postmedial fascia from costa at two-thirds, bowed and roughly parallel with termen to vein *Cu2*, thence slightly oblique inwardly to inner margin; beyond the postmedial fascia to the termen Dresden brown, with two subterminal whitish patches, one, roughly circular, on vein *M2*, the other larger, commencing on vein *Cu1*, broadening to about 1½ mm. on vein *Cu2* and decreasing to 1 mm. near the tornus; on the distal two-thirds of the wing the veins are outlined with white to cartridge buff; fringe worn in the type and paratype, but apparently concolorous with the terminal area; inner margin with some long cartridge buff hair-scales. Hind-wing and fringe clove brown. Underside of fore-wing with basal third clove brown; medial area white; apical area, from a point just basad of the junction of vein *Sc* with the costa, to the junction of vein *Cu2* with the termen, clove brown to Dresden brown; a subterminal whitish patch on vein *M2* as on upperside. Underside of hind-wing clove brown, with a broad white costal streak above the upper angle of the cell, and a white patch on the termen, which commences broadly along vein *Cu2* and runs to a point at the tornus; some white irroration on the remaining portion of the preterminal area.

♀. Palpus buffy brown. Antenna antique brown, basal half of shaft streaked with cartridge buff. Thorax antique brown, with a few long upright cartridge buff hair-scales. Abdomen antique brown to tawny olive; anal tuft fuscous mixed with cartridge buff, large and bushy in some specimens, but less so in the type. Pectus and legs tawny olive, tarsus of fore-leg mainly cartridge buff. Fore-wing with basal portion antique brown, the distal boundary of this area shaped as in the ♂; a few long cartridge buff hair-scales scattered in and below the cell and on inner margin; medial area white, its shape similar to that in the ♂, but narrower towards the inner margin, and in some paratypes ceasing at the lower margin of the cell or vein *Cu2*; beyond this to the termen antique brown, with two subterminal whitish patches, shaped as in the ♂, but the lower one relatively smaller and finishing further from the tornus than in the ♂; fringe snuff brown. Hind-wing and fringe snuff brown. Underside of both wings snuff brown; the white medial area of the fore-wing as on upperside, but ceasing at vein *Cu2*, and a small white subterminal patch before the tornus; fringes snuff brown.

Expanse: ♂♂ 38 and 43 mm., ♀♀ 52–58 mm.

1 ♂ (holotype), 1 ♀ (allotype), 1 ♂ and 4 ♀♀ (paratypes), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 ft., December 1920–January 1921 (C., F., & J. Pratt).

Both sexes resemble in facies *Euproctis seminigra*, Joic. & Talb. (1915), in which the differences between the sexes present similar features.

Euproctis disphena, sp. n.

(Plate VII, fig. 1.)

♀. Palpus yellow ochre above, light orange yellow beneath. Antennal shaft ivory yellow, pectinations honey yellow. Head pale orange yellow. Thorax light buff streaked with light ochraceous buff, hair-scales of patagium and tegula long, and some underlying white hair-scales visible in the centre of the thorax. Abdomen light orange yellow, anal extremity fuscous black dorsally, cartridge buff laterally. Legs pale orange yellow, pectus light orange yellow. Fore-wing pale orange yellow; over the whole wing a series of rich mahogany red interneural streaks, the streaks between veins *M1* and *M2*, and *Cu1* and *Cu2*, thicker at the extremities than in the centre, the former preceded by some diffuse deep chrome from the discocellulars; between the anal vein and *Cu2* there are two streaks, the upper one curving to meet the lower at an acute angle near the base of the wing; in the cell are two short wedge-shaped streaks, the upper situated more basad than the lower, and both having the wedge points directed basad; fringe slightly darker than the ground-colour. Hind-wing light orange yellow, with faint interneural streaks of deep chrome; fringe light orange yellow. Underside of both wings light orange yellow; fore-wing with interneural streaks of ochre red, less well defined than on upperside, between each of the veins from *R4* to *Cu2*.

Expanse: 63 mm.

1 ♀ (holotype), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 ft., December 1920–January 1921 (C., F., & J. Pratt).

Euproctis pentatoxa, sp. n.

(Plate VII, figs. 13 and 14.)

♂. Palpus porrect (in some specimens, oblique ascending), cream buff, the 2nd segment Mars yellow above and below. Antennal shaft ivory yellow, pectinations honey yellow. Frons xanthine orange; vertex xanthine orange, with tufts of Naples yellow hair-scales posteriorly and at the base of each antennal shaft. Thorax Naples yellow, narrowly edged with xanthine orange in front; tegula with a central streak of Sanford's brown, and with some long, flattened ivory yellow hair-scales. Abdomen ivory yellow, basal area, and distal edge of each segment, xanthine orange. Legs Naples yellow, the fore-leg tinged in front with xanthine orange. Pectus and venter Naples yellow. Fore-wing straw yellow; a basal patch of Sanford's brown, narrow at inner margin, broadening towards costa, and extending along costa to within a short distance of the apex; a series of interneural streaks of mahogany red subbasally; a broad band of rich mahogany red slightly distal of the middle, and covering a good third of the wing area, increasing in width from inner margin to costa, its proximal edge inwardly oblique from costa to upper margin of cell, outwardly oblique to lower margin of cell, then inwardly oblique to 2nd anal vein and again outwardly oblique to inner margin, its distal edge inwardly oblique from costa to vein *M2*, then excurved to vein *Cu1* (concavity basad), and incurved to inner margin; within the band occur the following markings, all of the ground-colour:—a streak parallel to and touching the inner margin, a smaller streak below vein *Cu2*, a similar streak along vein *Cu2*, and a conspicuous five-rayed star having its centre at the lower angle of the cell, with three rays running distad for some distance along veins *M2*, *M3* and *Cu1*, and two shorter rays running along lower margin of cell and discocellulars; a further marking having its upper edge along the costa, its lower edge on the upper margin of the cell, and with four rays running from it, along veins *M1* and *R5*, the upper margin of the cell and discocellulars. A preterminal series of interneural streaks of mahogany red. Hind-wing massicot yellow.

Wings beneath massicot yellow, the fore-wing with a broad cinnamon rufous suffusion along the basal two-thirds of the costa and at the end of the cell, reproduced to a lesser extent in the hind-wing, and on both wings a series of faint interneural preterminal streaks of the same colour.

♀. Palpus, head and thorax Sanford's brown, 3rd segment of palpus much longer than in the ♂ and less hairy. Antenna ochraceous buff. Abdomen Mars yellow, anal tuft white. Fore-wing with similar markings to those in ♂, but the straw yellow replaced by white and the mahogany red by burnt sienna; the interneural streaks in the preterminal fascia relatively longer, and the fringe Sanford's brown. Hind-wing Mars yellow, the veins lighter. Wings beneath Mars yellow, the veins indistinctly lighter.

Expanse: ♂♂ 35-43 mm., ♀♀ 48-53 mm.

1 ♂ (holotype), 1 ♀ (allotype), 73 ♂♂ and 3 ♀♀ (paratypes), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 feet, November-1920-January 1921 (C., F., & J. Pratt).

Euproctis apatetica, sp. n.

(Plate VI, fig. 15.)

♂. Palpus capucine yellow, the 2nd segment with some fuscous scales on the outer side. Antennal shaft cartridge buff, sparsely irrorated with ochraceous tawny, pectinations ochraceous tawny. Head ochraceous tawny. Thorax hair brown, patagium buffy brown, tegula with some long cream-buff hair-scales. Abdomen capucine yellow, anal tuft slightly lighter. Pectus and venter ochraceous buff to capucine yellow. Legs with tibiae and tarsi cartridge buff, femora tinged with ochraceous buff, fore tibia fuscous on the inner side. Fore-wing Prout's brown; along the discocellulars a large oval spot, light orange yellow, rounded at the upper angle of the cell, somewhat pointed towards the lower angle of the cell, which in the type and most of the paratypes it does not quite reach; fringe ivory yellow, and on the inner margin a few long flattened hair-scales of light orange-yellow. Hind-wing light orange yellow, the area between the cell and the inner margin covered with long hair scales; fringe ivory yellow. Underside of both wings pale orange yellow, the distal half of the fore-wing tinged with vinaceous fawn, which darkens towards the termen; fringes ivory yellow.

Expanse: ♂♂ 43-50 mm.

1 ♂ (holotype) and 5 ♂♂ (paratypes), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 ft., December 1920 January 1921 (C., F., & J. Pratt). 1 ♂ (paratype), Biagi, Mambare River, British New Guinea, 5000 ft., March 1906 (ex Oberthür collection) (A. S. Meek).

Allied to *Euproctis albociliata*, B.-Bak. (1904), which, however, has the abdomen black with a bright yellow terminal segment and anal tuft, the terminal area of the fore-wing narrowly white in addition to the fringe, and a patch of black on the basal and part of the inner marginal area of the hind-wing.

Euproctis poliocerca, sp. n.

(Plate VII, fig. 3.)

♂. Palpus, antenna, legs and head antimony yellow. Thorax Mars yellow. Abdomen amber brown, with a large bushy anal tuft having a "greyish" appearance, the hair-scales composing it varying in shade from cartridge buff to olive brown. Fore-wing Mars yellow; a broad band of ivory yellow, with edges parallel but not sharply defined, commencing at

the lower angle of the cell and inwardly oblique to a point on the inner margin slightly nearer to the base than to the tornus; a series of preterminal ivory yellow neural streaks, those on *Cu*1, *Cu*2 and anal vein joined up to form a rather broader light-coloured patch with indefinite boundaries; fringe Mars yellow with a lighter line at its base. Hind-wing Mars yellow, a little lighter towards the termen; fringe Mars yellow. Underside of both wings Mars yellow, fringes with a light line at their base; fore-wing with a series of faint preterminal pale ivory-yellow neural streaks.

♀. Palpus, antenna, legs and body ochraceous tawny, anal tuft similar to that of ♂, but the underlying hair-scales fuscous black. Wings and fringes ochraceous tawny. On fore-wing an indistinct lighter patch at the junction of vein *R*5 with the stalk of veins *R*2 to *R*4, and an indistinct lighter band from the lower angle of the cell to the inner margin, bowed, concavity tornad.

Expanse: ♂♂ 48–51 mm. ♀♀ 51–54 mm.

1 ♂ (holotype), 1 ♀ (allotype), 7 ♂♂ and 2 ♀♀ (paratypes), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 ft., November 1920–January 1921 (*C., F., & J. Pratt*).

Resembles *Euproctis coniochroa*, B.-Bak. (1909). The type ♂ of this species is unique, and somewhat rubbed, but there appears to be no pattern on the fore-wing as in the insect described above, and the ground-colour is more dingy.

***Euproctis tetrabalia*, sp. n.**

(Plate VII, fig. 11.)

♂. Palpus, antenna, legs, head and thorax Mars yellow to amber brown. Abdomen amber brown, with a bushy anal tuft having a "greyish" appearance, the hair-scales composing it varying from cartridge buff to olive brown. Fore-wing Mars yellow; four large white spots—one, oblong, filling most of the distal end of the cell but not reaching the lower angle; another, oblong, running from a point just beneath the junction of vein *Cu*2 with the cell, inwardly oblique to the inner margin at one-third; the third in the subterminal area, triangular, between veins *M*1 and *M*3, with one angle resting on vein *M*3; and the fourth, also in the subterminal area, between vein *Cu*1 and the inner margin, its distal edge straight and parallel with the termen, its proximal edge bowed and roughly semicircular; fringe buckthorn brown. Hind-wing yellow ochre, fringe buckthorn brown. Underside of both wings yellow ochre to clay colour; on the fore-wing a broad indistinct cartridge-buff medial fascia, from the upper angle of the cell to the inner margin; on the hind-wing a broad indistinct cartridge-buff subterminal fascia, running parallel with the termen; fringes as on upperside.

Expanse: ♂♂ 48–54 mm.

1 ♂ (holotype) and 4 ♂♂ (paratypes), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 ft., December 1920–January 1921 (*C., F., & J. Pratt*).

Probably closely related to *Euproctis poliocerca*, described above.

***Euproctis amegethes*, sp. n.**

(Plate VII, figs. 4 and 5.)

♂. Palpus orange, streaked with fuscous on the outer side. Antenna Mars yellow, irrorated towards the tip of the shaft with fuscous. Head and thorax orange, tegula tinged with xanthine orange. Abdomen orange proximally to xanthine orange distally; anal tuft white. Pectus and legs orange buff to xanthine orange, tarsi fuscous. Venter

whitish, with some orange-buff scales at the end of each segment. Fore-wing amber brown; a circular (in some specimens slightly oblong) white spot placed subbasally between the lower margin of the cell and the anal vein; a further white spot, circular and of similar size, on the discocellulars, reaching from the upper angle of the cell to the lower; a sub-terminal fascia of cadmium yellow running parallel with the termen from vein *M*2 to the anal vein, the edges indistinct and merging into the ground-colour; with the exception of veins *Sc* to *R*2 and the upper margin of the cell, all veins are outlined with cream buff and edged with cadmium yellow; fringe amber brown, with cream buff and cadmium yellow at the vein-ends. Hind-wing cadmium yellow, tinged along termen and inner margin with deep chrome; fringe deep chrome, lightly tinged with amber brown. Underside of both wings cadmium yellow tinged with deep chrome; terminal, apical and costal area of the fore-wing, except on the veins, suffused with amber brown; fringes of both wings amber brown, with deep chrome at the ends of the veins.

♀. Palpus bistre mixed with cartridge buff. Antenna honey yellow, irrorated towards the tip of the shaft with fuscous. Frons light orange yellow, vertex ochraceous orange. Thorax orange. Abdomen orange proximally to xanthine orange distally; anal tuft drab, ringed at the base with whitish. Pectus and legs ochraceous orange, tibiae and tarsi suffused with fuscous. Venter cartridge buff suffused with xanthine orange. Fore-wing tawny to russet, the preterminal area darker, the veins over the whole wing somewhat lighter; an indistinct whitish oval spot at the base between cell and anal vein; a large indistinct whitish spot on the discocellulars; fringe ochraceous buff mixed with tawny, lighter at the ends of the veins. Hind-wing cadmium yellow tinged with deep chrome and shaded before the termen with russet; fringe light orange yellow tinged with russet.

Expanse: ♂♂ 39-44 mm., ♀ 55 mm.

1 ♂ (holotype) and 3 ♂♂ (paratypes), Nomnagihé, 25 miles south of Wangaar, Dutch New Guinea, 2000 ft., January-February 1921 (*C., F., & J. Pratt*). 1 ♀ (allotype) and 1 ♂ (paratype), Ninay Valley, Central Arfak Mountains, Dutch New Guinea, 3500 ft., November 1908-January 1909 (*A. E. Pratt*). 1 ♂ (paratype), Wandammen Mountains, Dutch New Guinea, 3000-4000 ft., November 1914 (*A., C., & F. Pratt*). 1 ♂ (paratype), Dinawa, British New Guinea, 4000 ft., May-July, 1902 (*A. E. Pratt*).

This insect strongly resembles *Heracula leonina*, Turner (1903), with which it has previously been placed in some collections. It is undoubtedly a separate species. *Heracula leonina* differs widely in shape, appearance and structure from the genotype *Heracula discivitta*, Moore (1865), and should be transferred to *Euproctis*, where it may be ranged near to *E. pratti albonotata*, Joic. & Talb. (1916). The following points of difference between *E. amegethes* and *E. leonina* will serve to separate them:—*E. leonina*. ♂. Expanse in 37 specimens 48-59 mm., average 53½ mm.; spot on discocellulars of fore-wing, oval; anal tuft drab to deep chrome, ringed at the base with white. ♀. Expanse in 13 specimens 67-76 mm., average 71½ mm. *E. amegethes*. ♂. Expanse in 7 specimens 39-44 mm., average 42½ mm.; spot on discocellulars, circular; anal tuft white. ♀. Expanse (allotype) 55 mm.

***Euproctis lipara*, sp. n.**

(Plate VII, figs. 6 and 7.)

♂. Palpus and frons deep chrome, vertex Mars yellow. Antenna ochraceous tawny. Patagium Mars yellow, tegula anteriorly Mars yellow, posteriorly burnt sienna, remainder of thorax rich mahogany red. Abdomen fuscous black, anal tuft cream buff. Pectus cream buff. Legs cream buff, tibia and tarsus of hind-leg with some long fuscous black

hairs. Fore-wing Kaiser brown; a basal patch of ivory yellow and deep chrome between the anal vein and the inner margin; basal half of the cell, and the costal area from base to termen, Naples yellow lightly irrorated with wood brown and deep chrome; distal half of the cell and the space between veins *R*5 and *M*2, as far as the subterminal area, rich mahogany red, mixed with orange rufous, and bisected by a discocellular streak of Naples yellow and wood brown mixed; a subterminal fascia of deep chrome irroration, commencing at vein *R*4 and finishing at the tornus, its proximal edge waved, its distal edge indefinite and roughly parallel with the termen; fringe fuscous, becoming lighter towards the apex, and with a lighter line at its base. Inner margin with a fringe of long flattened Kaiser brown hair-scales. Hind-wing orange, paler at costa, and with a black semicircular area, of which the inner margin forms the straight edge; fringe light orange yellow, mixed with orange. Underside of fore-wing with basal half deep chrome, distal half (except for a patch of deep chrome at the apex), fuscous black, the division occurring from the tornus to the costa at one half. Underside of hind-wing as on upperside, but the orange replaced by deep chrome.

♀. Similar to ♂, but the colouring less bright. Anal tuft Saccardo's umber, cartridge buff laterally. Underside of fore-wing with the fuscous area continued to the apex, where there is some sparse light orange-yellow irroration, which colour also extends along the costa.

Expanse: ♂♂ 40–47 mm., ♀ 63 mm.

1 ♂ (holotype), 1 ♀ (allotype), and 7 ♂♂ (paratypes), Nomnagihé, 25 miles south of Wangaar, Dutch New Guinea, 2000 ft., January–February, 1921 (*C., F., & J. Pratt*).

Somewhat resembles *Euproctis semirufa*, Joic. & Talb. (1917), but among other differences the ♂ of *semirufa* has the black area on the hind-wing narrower, and entirely lacks the band of fuscous black on the underside of the fore-wing.

***Paraxena drepanoides*, sp. n.**

(Plate VII, fig. 9.)

♂. Palpus cartridge buff, above and on the outer side ochraceous tawny; 3rd segment downturned. Antenna light buff, the shaft somewhat darker. Head, thorax and abdomen light buff, the anal tuft above with some drab hair-scales. Legs light buff, the fore tarsus antique brown, tipped with white. Fore-wing white; on the inner margin, below the middle of the cell, a small patch of snuff brown, drawn to a point midway between the anal vein and *Cu*2; a patch of snuff brown running from the apex along the costa to a point just short of the areole, its proximal edge at right angles to the costa and its lower edge running from midway between veins *R*5 and *M*1 to the apex; a large three-cornered patch of snuff brown, with some white intermixed, occupying the whole of the tornal area, its edge running in an approximately straight line from the termen below vein *R*5 to the inner margin at one-half; all the veins in the wing, except in the costal area, defined to some extent with snuff brown, and traces of a line of the same colour along the middle of the cell and between the anal vein and *Cu*2; fringe snuff brown, at the vein-ends white. Hind-wing white, the principal veins very faintly defined with cartridge buff; fringe white. Underside of both wings white; the costal margin of the fore-wing narrowly defined with warm buff in the proximal half and cream buff in the distal half; fringes white edged with snuff brown.

Expanse: ♂♂ 26–30 mm.

1 ♂ (holotype) and 1 ♂ (paratype), Bitje, Ja River, Cameroons, October, wet season (*G. L. Bates*); also 6 ♂♂ (paratypes) from the same locality, 2000 ft.,

October–November 1912; also 1 ♂ (paratype), Mabera Forest, Kyagive, Mulange, Uganda, April–August 1919 (*R. A. Dummer*).

This insect agrees well in structure with *Paraxena angola*, B.-Bak. (1911), which also occurs in the Cameroons. It should be noted that the genotype, *Paraxena esquamata*, B.-Bak. (1911), has two pairs of spurs on the hind tibia, not one pair as stated in the description. *P. angola* and the species described above have also two pairs of spurs on the hind tibia.

Aroa pampocila, sp. n.

(Plate VI, fig. 1.)

♂. Palpus, head, thorax and legs white intermixed with fuscous in varying proportions, giving a "greyish" appearance. Antennal shaft cartridge buff, irrorated with fuscous, pectinations honey yellow. Abdomen fuscous, each segment edged distally with white scales and hair-scales, the hair-scales becoming darker and more numerous towards the base, until, on the two basal segments, they merge with and resemble those on the thorax; anal tuft honey yellow mixed with fuscous. Pectus whitish. Venter white proximally to cream buff distally. Fore-wing varicolorous; basal half of wing drab, mixed with fuscous, light campanula blue and burnt sienna; between the cell and the inner margin the light campanula blue predominates; a basal, a subbasal and an antemedial fascia of burnt sienna, each wavy and at right angles to the costa, the basal and subbasal rather narrow, the antemedial about a millimetre broad; a fuscous reniform spot, edged with fuscous black; beyond the reniform a conspicuous elongate whitish patch, lightly irrorated with drab, situated between veins *R*5 and *Cu*2 and extending outwards as far as the subterminal area; a fuscous postmedial fascia consisting of a fine line roughly parallel with the antemedial fascia; a broad indistinct subterminal fascia of scattered burnt sienna and fuscous scales, broadening above vein *M*1 into a subapical patch of burnt sienna about 2 mm. broad; beyond the subterminal fascia to the termen fuscous mixed with light campanula blue; fringe Sudan brown edged with cartridge buff. Hind-wing mummy brown; a mummy brown shade on the discocellulars, and beyond this a white central elongate patch stretching from vein *M*1 almost to vein *Cu*1; the cell, and the inner marginal area to the tornus, broadly covered with long whitish hair-scales. Fringe as on fore-wing. Underside of fore-wing mummy brown; the light patch on the upperside reproduced below in white, and extended to include the tornus and the whole of the cell, except a wedge-shaped patch on the discocellulars. Underside of hind-wing white, with cartridge buff on the costa; apical and terminal area, as far as vein *Cu*2, mummy brown, with some burnt sienna irroration towards apex, a fuscous spot on the discocellulars, some light mummy-brown irroration between the inner margin and the cell, and some campanula blue irroration before the termen. Fringes as on upperside.

Expanse: ♂♂ 29–31 mm.

1 ♂ (holotype) and 6 ♂♂ (paratypes), west side of Marungu Plateau, S.W. Tanganyika, 7000 ft., February 1922 (*T. A. Barns*).

This species is perhaps nearest to *Aroa leonensis*, Hmps. (1910), from Sierra Leone (type in B.M.). The fasciae of the fore-wing are similarly arranged, but in *A. leonensis* the whitish patches on both wings are only faintly indicated, and the hind-wing is slightly longer and narrower. The B.M. possesses no specimen of *Aroa quadrimaculata*, Janse (1915), the type of which comes from Rhodesia, but in that species the fasciae are described as whitish. *Aroa melanoleuca*, Hmps. (1905) (type in B.M.), is a very different and much smaller species, without fasciae on the fore-wing, and the illustration in Seitz's

Macrolepidoptera of the World (14, pl. 22g) is certainly not of that species, but bears much resemblance to *Aroa pampoecila* here described.

***Fodinoidea rectifascia*, sp. n.**

(Plate VI, fig. 12.)

♂. Palpus with basal two-thirds of 1st segment scarlet, distal one-third dark vandyke brown, basal half of 2nd segment scarlet, distal half, and whole of 3rd segment, dark vandyke brown. Antenna fuscous. Head and thorax dark vandyke brown, the line of their junction scarlet red. Abdomen scarlet, with a dark spot dorsally on each segment (obsolescent in the type, distinct in some other specimens), and a dark vandyke-brown dorsal crest on the first two segments. Pectus, legs and venter dark vandyke brown. Fore-wing dark vandyke brown, becoming slightly lighter in the terminal area; a conspicuous and straight cartridge-buff postmedial fascia, $1\frac{1}{2}$ mm. broad, from the costa above the junction of vein *R*1 with the cell to the inner margin at two-thirds, the fascia forming with the basal section of the inner margin an angle very slightly less than a right angle; fringe vandyke brown. Hind-wing with basal half pale orange yellow, slightly darker towards inner margin; distal half, from a line running from the tornus to the costa at one half, vandyke brown; inner margin narrowly edged with vandyke brown. Underside of both wings as on upperside, but the dark vandyke brown replaced by Rood's brown; on the hind-wing the pale orange-yellow area is reduced, the space between the lower margin of the cell and the costa being filled in with Rood's brown.

♀. Resembles the ♂, but the vandyke brown area on the hind-wing is relatively broader, occupying considerably more than half the wing area.

Expanse : ♂♂, 43–51 mm., ♀ 62 mm.

1 ♂ (holotype) and 9 ♂♂ (paratypes), Central Madagascar, 2500 ft., January–March, 1911 (*F. B. Pratt*); 1 ♀ (allotype), Vohemar, Madagascar (ex Oberthür collection).

This species much resembles *Fodinoidea staudingeri*, Saalm. (1884), and in the B.M. collection there are 13 ♂♂ of the latter with precisely the same data as the present series of *F. rectifascia*. In *F. staudingeri* the white fascia on the fore-wing is at a markedly different angle, commencing at about the centre of the costa and running to the tornus; also the fringe of the fore-wing is white and joins the fascia at the tornus. *F. vectigera*, Mab. (1882), *F. staudingeri* and *F. rectifascia* all possess a short proboscis, withdrawn between the palpi and invisible in most specimens, but very easily seen in others.

***Laelia corallina*, sp. n.**

(Plate VI, fig. 8.)

♂. Palpus with 1st and 2nd segments auburn mixed with fuscous, 3rd segment fuscous basally, avellaneous distally. Antennal shaft coral red, pectinations fuscous at base, remainder Isabella colour. Head and thorax auburn mixed with fuscous. Abdomen bistre to snuff brown, with some long hair-scales dorsally at the base. Pectus and legs fuscous mixed with vinaceous brown. Venter fuscous. Fore-wing drab, thinly covered with scales and hair-scales of coral red, and lightly irrorated with fuscous black, the wing having a "pinkish" appearance; a fuscous striga along the discocellulars; a postmedial fascia composed of indistinct interneural fuscous spots, roughly parallel with the termen to below vein *M*3, then oblique inwardly to below vein *Cu*2, the last spot being larger than the others; fringe drab mixed with coral red. Hind-wing and fringe drab to fuscous. Under-

side of both wings drab, with a slight chestnut and coral red suffusion along both costal margins.

Expanse: 31 mm.

1 ♂ (holotype) and 1 ♂ (paratype), Rugege Forest, Ruanda District, Lake Kivu, Belgian Congo, 8000 ft., December 1921 (*T. A. Barns*).

Resembles *Laelia lavia*, Swinh. (1903), from British East Africa, which, however, lacks the coral red on wings and antennal shaft.

***Dasychira thysanogramma*, sp. n.**

(Plate VI, fig. 11.)

♂. Palpus mummy brown proximally, ochraceous buff distally. Antennal shaft mummy brown irrorated with cartridge buff, pectinations fuscous black. Frons cream buff lightly streaked with fuscous, vertex mummy brown, with a white ring at the base of each antennal shaft. Thorax with rather long hair-scales, of mixed fuscous black, mummy brown and cartridge buff; pectus somewhat lighter. Abdomen cartridge buff laterally, light buff streaked with fuscous dorsally, and with a thick dorsal tuft of bone brown on the basal segments. Legs fuscous black, ringed and streaked with ochraceous buff and cartridge buff. Fore-wing mottled and irrorated with amber brown, dark metallic bluish glaucous, fuscous and fuscous black; two basal spots of fuscous black; base of inner margin cartridge buff; a subbasal and an antemedial fascia, both more distad than their usual position, the former not well defined, largely of dark metallic bluish glaucous, the latter crenate, fuscous black; between these two fasciae, and between the subbasal fascia and the base of the wing, the area is mainly amber brown, with a broad patch of dark metallic bluish glaucous above the anal vein; medial area dark metallic bluish glaucous, irrorated with fuscous black, and with a conspicuous white patch about 3 mm. broad stretching from vein *Cu*2 to the inner margin, the lower part of the postmedial fascia running through it; an oval amber brown reniform spot, edged with fuscous black; a crenulate postmedial fascia of fuscous black, bowed (concavity basad), from costa to vein *Cu*2, where it almost touches the antemedial, thence obliquely bowed to inner margin at three-quarters; beyond this to the termen amber brown, shaded with patches of fuscous black, and with a broken white subterminal fascia, most prominent at the tornus; fringe fuscous black, marked with white at the end of each vein. Hind-wing white to cartridge buff, the distal third irrorated with buffy brown; fringe buffy brown, marked with white at the end of each vein. Underside of both wings white to cartridge buff; fore-wing with some fuscous and buffy brown shading along the costa and in the distal half of the cell, and to a lesser extent over the rest of the wing excepting the inner marginal area; a well-defined fuscous postmedial fascia, slightly bowed (concavity terminad), and a faintly defined fuscous reniform spot; fringe as on upperside; hind-wing with some fuscous and buffy brown irroration in the costal area, and a fuscous postmedial fascia, parallel with the termen, which ceases before reaching the anal vein; a faint fuscous shade on the discocellulars; fringe as on upperside.

Expanse: ♂♂ 41 mm.

1 ♂ (holotype) and 2 ♂♂ (paratypes), Rugege Forest, Ruanda District, Lake Kivu, Belgian Congo, 7000 ft., December 1921 (*T. A. Barns*).

***Dasychira chloebapha*, sp. n.**

(Plate VI, fig. 3.)

♂. Palpus warm buff to aniline yellow, above and on the outer side Prout's brown, the 3rd segment short and its point of junction with the 2nd segment concealed by the hair-

scales. Antennal shaft aniline yellow streaked with fuscous black, pectinations bone brown. Head and thorax aniline yellow to sulphine yellow. Abdomen Mars brown, each segment narrowly edged posteriorly with cream buff, and dorsal tufts of aniline yellow on the basal segments. Legs warm buff, marked with fuscous on the uppersides, and the tibiae of the fore and middle legs with some aniline yellow hair-scales. Pectus and venter warm buff. Fore-wing sulphine yellow to aniline yellow, giving a dull "green" appearance; a subbasal and an antemedial fascia, each composed of two crenulate Prout's brown lines, running at right angles to the costa; below the anal vein from the subbasal fascia to the base the area is filled in with Prout's brown; a small Prout's brown spot in the cell beyond the antemedial fascia; some irregular fuscous spots along the costa to the apex; a reniform spot outlined with Prout's brown and filled in with ground-colour, the proximal edge running along discocellulars, the distal edge deeply indented at the middle; a postmedial fascia, composed of two crenate lines of Prout's brown, the space between filled in with yellowish glaucous, which starts above the reniform, skirts its distal side and curves in below it to vein *Cu*2, thence outwardly oblique to the inner margin; a broad and irregular subterminal fascia of Prout's brown, ceasing on vein *Cu*1 and continuing again more basad but from the same vein; a preterminal fascia of Prout's brown, more regular than the others, roughly parallel with the termen, broken at the veins and edged with yellowish glaucous; fringe deep chrome, tipped with ivory yellow, and marked interneurally with Prout's brown. Hind-wing Mars brown; fringe ivory yellow, deepening to deep chrome opposite the ends of the veins, and the ground-colour of the wing extending interneurally into the fringe. Under-side of both wings snuff brown, fringes warm buff to ivory yellow, invaded interneurally by the ground-colour of the wings; some buckthorn brown along the costal margin of the fore-wing, and some faint fuscous shading on the discocellulars and in the subterminal area of the hind-wing.

♀. Similar in general appearance to the ♂, but much larger. The 3rd joint of the palpus is thin, and almost as long as the breadth of the eye. Antennal shaft fuscous black. The hair-scales on the abdomen of the type are worn and there is little trace of either dorsal or anal tufts. The fore-wing has a lighter appearance owing to the rather more extensive areas of ground-colour; the fasciae are mummy brown; the distal edge of the reniform is heavier than in the ♂, and the most prominent marking on the wing.

Expanse: ♂ 46 mm., ♀ 74 mm.

1 ♂ (holotype), Tamatave, Madagascar (*Dr. Martin*) (ex Oberthür collection);
1 ♀ (allotype) Vohemar, Madagascar.

***Rajacoa melanophleps*, sp. n.**

♀. Palpus short, drab, tipped with fuscous. Antenna drab, the shaft streaked with fuscous. Head drab. Thorax whitish. Abdomen clothed scantily with short fuscous hair-scales, through which can be seen the honey yellow of the body surface, each segment edged posteriorly with some whitish hair-scales, and some longer whitish hair-scales dorsally on the basal segments. Pectus scantily covered with whitish hair-scales, venter with some fuscous hair-scales. Legs sepia, the femora only sparsely covered with hair-scales. Wings semi-hyaline, the surface above and beneath covered with short fuscous black hair-scales, giving a "greyish" appearance; veins dark coloured and prominent, especially in the basal area of the fore-wing, where the membrane below the anal vein is tinged with fuscous; the basal third of the fore-wing and the basal half of the hind-wing with some delicate whitish hair-scales, which have been worn away in a number of the paratypes, but in the type and other fresh specimens are thick enough to render the wing almost opaque.

Expanse: ♀♀ 51-59 mm.

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1 ♀ (holotype) and 12 ♀♀ (paratypes), Mt. Kunupi, Menoo Valley, Weyland Mountains, Dutch New Guinea, 6000 ft., November 1920–January 1921; 1 ♀ (paratype), Dewara Village, Weyland Mountains, 3500 ft., June, 1920. All collected by Messrs. C., F., and J. Pratt.

***Abynotha preussi*, Mab. & Vuill.**

(Plate VI, fig. 10.)

Liparis preussi, Mabille and Vuillot, Nov. Lep. 7: 57; pl. 9, fig. 5, 1892.

♀. Palpus cinnamon buff, 3rd segment long and not concealed by the hairs of the 2nd segment. Antenna black. Head and thorax snuff brown, tegula with some erect hair-scales tipped with black. Abdomen marguerite yellow, the distal end of each segment broadly edged with mummy brown, giving an effect of stripes, which do not extend to the venter; anal tuft ochraceous tawny to ochraceous orange; venter cartridge buff streaked with ochraceous tawny. Legs tawny olive shaded with bistre, the tarsus of the middle leg olivaceous black. Fore-wing cartridge buff, densely irrorated with cinnamon brown; four fasciae indicated by an increase in the irroration—basal, subbasal, antemedial and postmedial, in each case crenate and bowed (concavity basad), and considerably broader and more heavily marked towards the costa; at the end of the cell a large reniform spot (convexity basad) outlined except on its distal edge and on the veins with spots of Prout's brown; a light-coloured medial patch, caused by a decrease in the irroration, between vein *Cu*2, the reniform spot and the postmedial fascia; a faint irregular subterminal fascia indicated by a decrease in the irroration, and a preterminal line, formed in the same manner, parallel to the termen; fringe cartridge buff, streaked with cinnamon brown, and chequered interneurally with mummy brown. Hind-wing with a white oval central area, having its centre at the lower angle of the cell and reaching to a point midway between the discocellulars and the termen; a broad band of cinnamon brown along the costa and termen, finishing at the anal angle; the basal half of the cell and the area between vein *Cu*2 and the inner margin tawny olive; a diffuse spot of cinnamon brown below the upper angle of the cell; fringe cartridge buff, chequered between the veins with mummy brown. Underside of both wings tawny olive with a white central area; a narrow kidney-shaped patch of Prout's brown along the discocellulars in the fore-wing, and a small spot of the same colour below the upper angle of the cell in the hind-wing; fringes cartridge buff, chequered between the veins with mummy brown.

Expanse: 76–91 mm.

Neallotype ♀, Bitje, Ja River, Cameroons, 2000 ft., October–November 1913, wet season. 2 ♀♀, Bitje, Ja River, May–June 1919 (*G. L. Bates*).

I am indebted to Lord Rothschild for pointing out to me the affinities of this insect. The B.M. collection contains 36 ♂♂ taken by various collectors in the Cameroons, but the ♀, now described for the first time, would appear to be rare.

***Lymantria dictyodigma*, sp. n.**

(Plate VII, fig. 15.)

♂. Palpus orange buff mixed with scarlet red; the 3rd segment tipped with fuscous black, and some fuscous black hair-scales on the front of the 2nd segment. Antennal shaft scarlet red, pectinations honey yellow, fuscous at base. Head orange buff, with a patch of Sanford's brown mixed with fuscous on the vertex, and on the frons a horseshoe-shaped mark, similarly coloured, with ends directed upwards. Thorax orange buff; a streak of Sanford's brown mixed with fuscous across the patagium; tegula cartridge buff to orange

buff, edged with Sanford's brown and fuscous. Abdomen coral red, tinged at the base with scarlet red; anal tuft white. Pectus light buff, orange buff in front. Venter cartridge buff. Legs light buff tinged with orange buff, the tarsi scarlet red to coral red; the fore-leg with femora and sides of tibia scarlet red; the latter banded proximally and medially with fuscous black, the tarsal segments fuscous black proximally; the mid tibia lightly tinged with coral red and banded with fuscous; the hind tibia light buff. Fore-wing white; basal third, as far as the antemedial fascia, orange buff; a circular basal mark of Sanford's brown and fuscous, joined to the base and to the costal margin, and centred with white; a subbasal fascia of circular interneural marks of Sanford's brown, centred with whitish; an antemedial fascia of Sanford's brown, oblique outwardly from the costa to a point below the junction of vein *Cu*2 with the cell, then inwardly oblique to the anal vein, and outwardly oblique to inner margin; in the cell, between the antemedial and the discocellulars, a circular mark and a half circle (the latter with concavity terminad) of Sanford's brown; a broad medial fascia, bistre edged with Sanford's brown, broadest at the costa, oblique inwardly from the costa at two-thirds to the inner margin at one-half; a postmedial fascia composed of a double line of Sanford's brown, each crenate, concavities terminad, points on the veins; on each side of the postmedial fascia, from the termen to the medial fascia, the veins are outlined with Sanford's brown on the white ground; an irregular subterminal bistre fascia; termen irregularly edged with Sanford's brown to bistre; fringe Sanford's brown and bistre, whitish at the ends of the veins. Hind-wing white; veins, inner margin and fringe tinged with cartridge buff. Underside of both wings white; the area on the fore-wing between the upper margin of the cell and the costa, from the base to a point just beyond the discocellulars, coral red, the costa edged with Sanford's brown, fuscous towards apex; cartridge buff suffusion in and below cell; veins cartridge buff; fringe orange buff, white at the vein-ends; hind-wing with costa and fringe cartridge buff.

Expanse: ♂ 39 mm.

1 ♂ (holotype), Upper Iowa Valley, near Masisi, W. Kivu, Belgian Congo, 5000—6000 ft., forest and long grass, wet season, February 1924 (*T. A. Barns*).

Lymantria leucerythra, sp. n.

(Plate VI, figs. 13 and 14.)

♂. Palpus clay colour mixed with fuscous. Antennal shaft fuscous black, pectinations bone brown. Head and thorax buffy brown, the thorax somewhat lighter posteriorly; a small patch of peach red at base of the antenna. Basal half of abdomen peach red, with a fuscous lateral line and a dorsal row of fuscous spots; posterior half snuff brown mixed with fuscous. Pectus and venter buckthorn brown. Legs Prout's brown, banded and tipped with peach red. Fore-wing buffy brown, crossed by a number of sepia crenate fasciae, a fuscous spot in the cell, followed by an angled fuscous streak along the discocellulars; below vein *Cu*2 the subterminal fascia broadens into an elongate patch which runs obliquely to the tornus; fringe of ground-colour, marked with fuscous interneurally, the markings extending slightly into the terminal area. Hind-wing sepia; the inner marginal area from base to anal angle covered with long peach-red hair-scales, a few of which are also present in the cell; the veins over the whole of the wing are also tinged with peach red; fringe sepia, peach red at the anal angle and tinged with the same colour at the ends of the veins. Underside of both wings Saccardo's umber faintly tinged with peach red towards the inner margins; a faint fuscous streak along the discocellulars in the fore-wing, and a spot of the same colour on the discocellulars of the hind-wing; fringes of ground-colour, with an interrupted darker line along their base.

♀. Antennal shaft Prout's brown, the basal segment peach red; pectinations bone brown. Head and thorax buffy brown; a small patch of peach red at the base of the antenna. Abdomen buffy brown, the basal half suffused with peach red. Pectus and venter buffy brown. Legs Prout's brown, banded and tipped with peach red. Fore-wing with similar markings to those of the ♂, but duller and less contrasted; traces of peach red on the fringe at the ends of the veins. Hind-wing drab; inner marginal area covered with long peach-red hair-scales as in the ♂, but to a lesser extent; the peach red is only faintly visible on the veins; fringe Saccardo's umber, peach red at the anal angle and tinged with the same colour at the ends of the veins.

Expanse: ♂ 43 mm., ♀ 59 mm.

1 ♂ (holotype), Zomba, Nyasaland, July 1925 (*H. Barlow*); 1 ♀ (allotype), (ex Neave collection, British Museum), bred from pupa, Mt. Mlanje, Nyasaland, 24th April, 1913 (*S. A. Neave*).

Lymantria sphalera, sp. n.

(Plate VI, fig. 6.)

♂. Palpus tawny olive, beneath and on the outer side fuscous. Antenna sepia, similar in shape to that of *L. lunata*, Stoll. Head and thorax pinkish buff, tegula with a single fuscous-black spot near its base. Abdomen grenadine. Legs tawny olive, the femora tinged with grenadine. Pectus tawny olive. Venter salmon orange. Fore-wing tawny olive dusted with Prout's brown; a fuscous-black basal spot just below the costa and another at the base of the cell; a series of subbasal fuscous-black spots placed interneurally; an irregular antemedial fascia, Prout's brown to fuscous black, passing through the junction of vein *Cu*2 with the cell; a fuscous-black spot at the upper and lower angles of the cell, a further spot on the centre of the discocellulars, and a fourth midway between the latter and the antemedial fascia; a sharply defined Prout's brown medial shade running straight across the wing, through the lower angle of the cell and at right angles to the inner margin; a crenate Prout's brown postmedial fascia with concavities terminad and the points on the veins, oblique outwardly from the costa to vein *M*1, then roughly parallel with the termen to the inner margin, where it touches the medial shade; a series of faint Prout's brown interneural subterminal spots; fringe tawny olive. Hind-wing light orange yellow, sometimes tinged with grenadine, and somewhat lighter towards the costa and at the base; fringe cinnamon buff. Underside of both wings ochraceous buff to ochraceous salmon, with a well-defined Prout's brown spot on the discocellulars; fringes capucine orange; on the fore-wing the antemedial and postmedial fasciae and the medial shade of the upper-side faintly reproduced below; on the hind-wing the discocellular spot is joined to the costa by a faint Prout's brown shade, followed by a faintly defined postmedial fascia, parallel with the termen and becoming obsolete before reaching the inner margin.

Expanse: ♂♂ 63–66 mm.

1 ♂ (holotype) and 2 ♂♂ (paratypes), November 1923–March 1924, New Ireland, Bismarck Archipelago (*A. F. Eichhorn*).

This species is very variable. The fasciae may disappear completely from the fore-wing or develop into broad and heavy bands, while the discocellular spots may be joined and extended to form a large conspicuous spot; the ground-colour of the hind-wings varies from light orange yellow to grenadine. In appearance the insect somewhat resembles *Lymantria lunata*, Stoll. (1781), but the arrangement of the fasciae on the fore-wing is very different.

Cispia joiceyi, sp. n.

(Plate VII, fig. 10.)

♂. Palpus orange buff, 2nd segment laterally Brussels brown. Antennal shaft cartridge buff, with a line of Prout's brown along the length of the shaft on upperside; pectinations Saccardo's umber. Head, thorax and abdomen light orange yellow to deep chrome; two fuscous black spots on the centre of the thorax; two fuscous black spots at the upper end of the tegula, which, with two similar spots at the base of the cell, form a row of four equidistant spots parallel (in set specimens) with the inner margin of the fore-wing; a series of fuscous black spots dorsally on the abdomen. Pectus deep chrome. Legs cream buff. Fore-wing cinnamon brown, veins outlined with avellaneous, and with a less prominent streak of avellaneous through the centre of the cell and between the more widely separated veins; an antemedial fascia composed of Prout's brown interneural spots, slightly bowed across the cell (concavity basad) and inwardly oblique to inner margin; beyond this a broad irregularly shaped area of light orange yellow, its distal edge incurved (concavity tornad) from the inner margin at one half to a point midway between the anal vein and *Cu2*, incurved again (concavity terminad) to the junction of vein *Cu1* with the cell, incurved again (concavity apicad) to the junction of vein *R1* with the cell, thence outwardly oblique to the costa; three subterminal spots of light orange yellow, one having its upper edge on vein *R5* and its lower edge between veins *M1* and *M2*, another, of similar size, reaching from vein *M3* to vein *Cu1*, and another, smaller, between the anal vein and *Cu2*; preterminal area, except at tornus, light orange-yellow; fringe light orange yellow, with a series of interneural cinnamon brown spots, which extend for a short distance into the preterminal area. Hind-wing light orange yellow, darkening slightly towards inner margin; some cinnamon brown shading at anal angle. Underside of both wings light orange yellow; a postmedial fascia across both wings, roughly parallel with the termen, composed of small interneural cinnamon brown spots; fore-wing with distal half of costa, above vein *R4*, buckthorn brown; a series of preterminal cinnamon brown interneural streaks, those between veins *R4*, *R5*, *M1*, *M2* and *M3* large, between *M3* and *Cu1* obsolescent, between the anal vein, *Cu2* and *Cu1* fairly well defined; preterminal streaks also on the hind-wing, between veins *M1*, *R5* and *R4*.

In the right fore-wing of the type and in both fore-wings of the paratype, vein *M1* is forked, with a wide angle, just before reaching the margin.

Expanse: ♂♂ 51 mm. and 54 mm.

1 ♂ (holotype), Nomnagihé, 25 miles south of Wangaar, Dutch New Guinea, 2000 ft., January–February 1921 (*C., F., & J. Pratt*); and 1 ♂ (paratype), Fak-fak, Dutch New Guinea, 1700 ft., December 1907 (*A. E. Pratt*).

Somewhat resembles *Cispia fasciata*, Semp. (1899), from Mindanao, but has a considerably richer appearance than the three specimens of that species in the British Museum collection, and more prominent projections terminad from the medial area.

Imaus apalochroa, sp. n.

(Plate VII, fig. 16.)

♂. Palpus whitish, laterally fuscous to fuscous black. Antennal shaft white, irrorated towards the tip with fuscous and Mars yellow, pectinations Mars yellow. Head and thorax whitish, and a broken ring of fuscous black round the eye. Abdomen whitish, laterally and on anal tuft somewhat tinged with drab. Pectus and legs whitish. Fore-wing whitish; three fuscous subbasal spots, one just beneath the costa, another, more distad, in the cell, and a third still more distad, just beneath the anal vein; a broken crenate antemedial

fascia, fuscous mixed with fuscous black, at right angles to the inner margin; five equidistant spots along the costal margin to the apex, of fuscous to fuscous black, of which the proximal one, above the discocellulars, is V-shaped with point directed apicad; a reniform spot, faintly outlined with fuscous, and filled in with slightly raised whitish scales; a crenulate fuscous postmedial fascia, broken at the veins, bowed (convexity tornad) from costa to vein *Cu*2, thence outwardly oblique to inner margin; a series of subterminal interneural fuscous spots, parallel with the termen; a series of terminal interneural fuscous-black spots; fringe whitish. Hind-wing whitish, lightly suffused with drab; a series of terminal fuscous spots, interneural, less prominent between veins *Cu*1 and *Cu*2; fringe whitish. Underside of both wings whitish, the distal half of the fore-wing, and the whole of the hind-wing excepting the area above the cell, very lightly tinged with drab; fringe whitish.

Expanse: ♂♂ 50–54 mm.

1 ♂ (holotype) and 23 ♂♂ (paratypes), Nomnagihé, 25 miles south of Wangaar, Dutch New Guinea, 2000 ft., January–February 1921 (*C., F., and J. Pratt*).

EXPLANATION OF PLATES VI AND VII.

PLATE VI.

- FIG. 1. *Aroa pampoecila*, sp. n. ♂ holotype (p. 78).
 2. *Porthmeia pyrozona*, sp. n. ♀ holotype (p. 67).
 3. *Dasychira chloebapha*, sp. n. ♂ holotype (p. 80).
 4. *Euproctis mycoides*, sp. n. ♂ holotype (p. 72).
 5. *Euproctis mycoides*, sp. n. ♀ allotype (p. 72).
 6. *Lymantria sphaera*, sp. n. ♂ holotype (p. 84).
 7. *Euproctis aeana*, sp. n. ♀ holotype (p. 71).
 8. *Laelia corallina*, sp. n. ♂ holotype (p. 79).
 9. *Soreutoneura daedala*, gen. & sp. n. ♂ holotype (p. 68).
 10. *Abynotha preussi*, Mab. & Vuill. ♀ neallotype (p. 82).
 11. *Dasychira thysanogramma*, sp. n. ♂ holotype (p. 80).
 12. *Fodinoidea rectifascia*, sp. n. ♂ holotype (p. 79).
 13. *Lymantria leucerythra*, sp. n. ♀ allotype (p. 83).
 14. *Lymantria leucerythra*, sp. n. ♂ holotype (p. 83).
 15. *Euproctis apatetica*, sp. n. ♂ holotype (p. 74).

PLATE VII.

- FIG. 1. *Euproctis disphena*, sp. n. ♀ holotype (p. 73).
 2. *Euproctis brunneipicta*, sp. n. ♀ holotype (p. 71).
 3. *Euproctis poliocerca*, sp. n. ♂ holotype (p. 74).
 4. *Euproctis amegethes*, sp. n. ♀ allotype (p. 75).
 5. *Euproctis amegethes*, sp. n. ♂ holotype (p. 75).
 6. *Euproctis lipara*, sp. n. ♂ holotype (p. 76).
 7. *Euproctis lipara*, sp. n. ♀ allotype (p. 76).
 8. *Euproctis hemicyclia*, sp. n. ♂ holotype (p. 69).
 9. *Paraxena drepanoides*, sp. n. ♂ holotype (p. 77).
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 11. *Euproctis tetrabalia*, sp. n. ♂ holotype (p. 75).
 12. *Euproctis amplior*, sp. n. ♂ holotype (p. 70).
 13. *Euproctis pentatoxa*, sp. n. ♀ allotype (p. 73).
 14. *Euproctis pentatoxa*, sp. n. ♂ holotype (p. 73).
 15. *Lymantria dictyodigma*, sp. n. ♂ holotype (p. 82).
 16. *Imaus apalochroa*, sp. n. ♂ holotype (p. 85).



NEW AFRICAN AND INDO-AUSTRALIAN LYMANTRIIDAE.



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NOTES ON THE GENUS *PAXYLOMMA* (HYM. BRAC.), WITH THE DESCRIPTION OF A NEW SPECIES TAKEN IN BRITAIN

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[Read December 4th, 1929.]

PLATE VIII.

INTRODUCTION.

SOME little time ago the senior author, when collecting in Windsor Forest, came across a species of *Paxylomma* that he was unable to recognise. The junior author shows below that this is a new species, and describes it, while the senior author gives some historical notes, together with a bibliography.

The excellent photographs of the wings were taken by Mr. W. H. T. Tams, of the British Museum, to whom the authors are greatly indebted.

SYSTEMATIC.

Paxylomma fuliginosi, sp. n.

♀. Black; scape, three basal joints of flagellum, the four front legs (except their coxae), red testaceous; face between the facial depressions, clypeus, mouth-parts, tegulae, four front coxae, pale testaceous; hind legs nigrescent red; wings evenly infuscated throughout, the stigma and veins black, or very dark brown.

♀. *Head*: face, frons, vertex, smooth save for some minute punctation; distance between posterior ocellus and the eye considerably greater than the diameter of an ocellus. *Thorax*: mesonotum entirely smooth in the median longitudinal third, and again towards lateral margins in posterior half, otherwise smooth with some minute punctation; scutellum with some minute punctation; propodeon in basal half with a very definite, narrow, straight, median, longitudinal sulcus, otherwise smooth save for some minute punctation, in apical half broadly rugose. *Fore-wings*: for details see Plate VIII, fig. 2. *Legs*: basal joint of hind tarsus rather longer than the four succeeding joints together, cylindrical, not compressed. *Abdomen* with tergites smooth save for some minute punctation and faint longitudinal aciculation; ovipositor sheaths short.

Length, 5 mm.

ENGLAND: Windsor Forest, Berkshire, 3 ♀♀, September, 1929 (*H. Donisthorpe*).

The described species referable to the genus *Paxylomma* would appear to number five, namely, *P. cremieri*, Romand, *P. grandis*, Rudow, *P. buccata*, Brébisson, *P. flavocincta*, Ashmead, and *P. rileyi*, Ashmead. Of these the last three are immediately distinguishable by the 2nd abscissa of the radial, which is punctiform and therefore considerably shorter than the 1st abscissa, whereas in the two first-mentioned species, and in *P. fuliginosi*, the 2nd abscissa of the radial is elongate, as long as or longer than the 1st abscissa (Plate VIII).

Of the species with the elongate 2nd abscissa of the radial *P. grandis* is not represented in the collections of the British Museum, and thus is not known to me; but Rudow states definitely that its venation is the same as that of

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cremieri, while it is clear from the description that its coloration is altogether different from that of *fuliginosi*. The remaining species, namely *cremieri*, may easily be separated from *fuliginosi* by the use of the following key, quite apart from colour characters which are equally distinct :—

- Recurrent elongate, virtually as long as the combined lengths of the 1st and 2nd abscissae of radial, these two latter equal; cubital vein strongly sinuate; stigma broad; distance between posterior ocellus and eye less than the diameter of an ocellus *cremieri*.
 Recurrent shorter than the combined lengths of 1st and 2nd abscissae of radial, of these latter the 2nd abscissa decidedly longer than 1st; cubital vein almost straight, at most very weakly sinuate; stigma narrow; distance between posterior ocellus and eye decidedly greater than the diameter of an ocellus *fuliginosi*.

It should be remarked also that neither is *P. flavocincta* known to me; but, on Ashmead's showing, this species has at least the venation with the punctiform 2nd abscissa of the radial as in *rileyi*.

It has been suggested that *fuliginosi* is nothing more than a venational variety of *buccata*. Apart therefore from the venational characters, which are markedly different, the vertex and occiput in *buccata* are decidedly coriaceous, but smooth in *fuliginosi*, while, in addition, the size of the vertex together with the relative size and position of the ocelli is quite distinct, these characters in themselves, in my opinion, affording sufficient ground for the erection of a new species.

Of the remaining groups placed in the PAXYLOMMATINAE the genera *Radio-laria*, *Ropronia*, and *Spilomma* are clearly distinct from *Paxylomma*, as may be seen from the illustrations of the wings in the original descriptions; it would seem even to be doubtful whether they are rightly placed in this subfamily. *Ogkosoma schwarzi*, Haupt, is separable from *P. fuliginosi* by means of its hind tarsi: so, for that matter, is *P. cremieri*.

HISTORICAL.

In 1817 Latreille wrote in the *Dict. Hist. nat.* under article "Paxylomme Paxylomma" that M. de Brébisson had communicated to him a very small Hymenopteron which he had discovered in the environs of Falaise and that it seemed to him to form a new genus to which he had given the name of *Paxylomma*. Latreille further said that no doubt M. de Brébisson would make known the natural characters of the genus so that its position could be determined.

In *Encyclopédie Méthodique*, 1825, under *Paxylomma*, it is stated that M. de Brébisson proposes this new genus of Hymenoptera. The characters are given, and the description of the species, *P. buccata*, follows, in which it is stated that he has described it from, and that he found it very common in, the dry and sandy environs of Falaise. The article is signed S.-F. and S. (= Le Peletier de Saint-Fargeau and A. Serville). At first sight it would appear that these are the authors of both genus and species, but as there is an indication that de Brébisson had described them, he must be treated as the author. One thing, however, is certain, the name of the genus must be spelt *Paxylomma* and not *Pachylomma* as is the custom now.

In 1833 Curtis described an insect, of which he had taken a female in the neighbourhood of London, under the name of *Planca apicalis* (= *Paxylomma buccata*, Bréb.).

In 1834 Nees von Esenbeck recorded that he had taken many females of *Hybrizon latebricola*, Nees (= *P. buccata*, Bréb.), in July and August at Sickerhausen in shady woods.

In 1835 Stephens pointed out that "*Paxyloma*" *apicalis*, Curtis, had been taken near London.

In 1838 de Romand described a new species of "*Paxylomme*," which had been sent to him by M. Crémière from Loudun, under the name of *P. cremieri*; and in the same year Zetterstedt described a male Hymenopteron, which he said was very rare in Lapland in woods in August, under the name of *Hybrizon pubicornis* (= *P. buccata*, Bréb.).

In 1839 Abel Ingpen recorded *P. buccata*, Bréb., from the New Forest; and in 1840 Blanchard recorded "*Paxylomma buccata*, Lep. et Serv." (!), from France and the north of Europe.

Ratzburg, in 1848, pointed out that the name *Paxylomma* is probably derived from *παχυλόν*, thick, and *το ὄμμα*, aspect. He recorded that *P. cremieri* was taken by Herr Tichbein in the neighbourhood of ants near the Rhine, and that Herr Hartig observed *P. buccata* hovering over the Coleopteron *Troscus adstrictor*. This last fact was certainly quite accidental.

In 1852 the same author mentioned that Herr Bach told him that he had once discovered a large colony of *Lasius fuliginosus* inhabiting a walnut tree, the nest being visible as the tree was cracked. In hot weather at the beginning of October, but never earlier, he observed a swarm of a Hymenopteron—*Hybrizon bachii*, Foerster (= *P. cremieri*, Romand)—hovering over the crack in the tree, and individuals from time to time would alight and rest on the trunk. The name *Hybrizon bachii* is probably a manuscript one, as I have been unable to trace it.

Giraud recorded that in the last quarter of October, 1857, he observed on several occasions, in oak woods in the neighbourhood of Vienna, a number of *Paxylomma cremieri*, Rom., which were all females, hovering over a colony of *Formica fuliginosa* and occasionally making little pounces at the ants. When frightened they disappeared with lightning quickness. He considered that they are parasitic on the ants, but in what manner was unknown, and judging by this experience and what he had observed with *P. buccata*, the latter insect having been seen hovering over a *Troscus*, had no significance.

Marshall observed *P. buccata*, Bréb., at Freshwater Bay, Pembrokeshire, in August 1866, frequenting the runs of a small cockroach, *Ectobia nigripes*, which swarmed on the sandhills. At that time he suspected the *Paxylomma* of being a parasite of the *Ectobia*.

Stein, in 1870, wrote that he had obtained a specimen of "*Eurypterna* (Foerst.) *cremieri*, Brébisson" (!), taken by a collector, on oak leaves at Dnieprs. He considered that the spelling of the name *Paxylomma* was incorrect, and that it should be spelt *Pachylomma*.

Rudow, in 1883, described a new species taken in an oak wood in Thüringen in the neighbourhood of a nest of *Camponotus herculeanus* under the name of "*Pachylomma grandis*, Gr." (!). It is probable that "*grandis*, Gravenhorst" was a manuscript name, as I have been unable to trace any such species published by that author.

Arnold, in 1881, gave a circumstantial account of the capture of "*Paxylomma* [sic] *cremieri*, Brébisson" (!), at Mohilew in Russia. During the years 1863–68 he always observed in September a number of this species hovering over a strong colony of *Lasius fuliginosus* which occurred in a shady oak wood. He pointed out that they had similar habits to those of *Paxylomma buccata* which

he had observed in July at Mohilew and Bychov hovering over the subterranean nests of *Lasius affinis*, and resting on the earth probably to lay their eggs.

Marshall, in 1891, recorded "*Pachylomma*" *buccata*, de Brébisson, from France, Corsica, Belgium, England, Austria and Germany. He had met with it in France at Nantua, in Corsica near Ajaccio, and three times in England, chiefly at Freshwater Bay, Pembrokeshire, lurking in great abundance among the rushes on the sandhills in company with *Myrmica scabrinodis*, etc.

"*Pachylomma*" *cremieri*, de Romand, he recorded from France; Oldenburg, Hanover; banks of the Rhine, Germany; environs of Vienna, Austria; and Russia. He quotes Giraud's records of both species.

In 1894 Wasmann recorded "*Eurypterna* (*Pachylomma*) *cremieri*, Bréb." (!), with *Lasius fuliginosus*, Latr., Central Europe; and "*Pachylomma buccata*, Nees" (!), with *Lasius affinis*, Schenck, Russia.

In 1896 Ashmead described two species of PAXYLOMMATINAE as "*Eupachylomma*" *rileyi*, Ashm., from Lafayette, Indiana, and "*Eupachylomma*" *flavocincta*, Ashm., from Arlington Heights on the banks of the Potomac, in 1889.

The first of these species he originally described as *Wesmaelia rileyi*, in 1888, from specimens ex Coll. Riley in the United States National Museum which had only a number and date, but no record of their habits, etc. Subsequently he received a single specimen from Prof. F. M. Webster bearing the same number and date. Prof. Webster informed him that he had bred all the specimens from an Aphid at Lafayette, Ind. It is probable that there is some mistake about this, judging from the habits of the European species.

In 1899 Wasmann recorded that Handmann took "*Pachylomma buccata*, Nees" (!), with *Lasius flavus* on July 31st, 1897, and with *Lasius affinis* on July 20th, 1897, at Travnik, Bosnia; and that he (Wasmann) had taken it with *Lasius brunneus* at Vienna in July 1897.

Marshall in his *Monograph of British Braconidae*, 1899, wrote of *Pachylomma buccata*, Bréb., that it is generally distributed throughout Europe wherever the ubiquitous ants of the genus *Myrmica* are established. He also said: "I have never had the chance of observing the manœuvres of the species in activity, vaulting over the nests of the ants and pouncing down upon the workers in order to deposit an egg in each of them. Such are the habits of the larger species, *P. cremieri*, observed by M. Giraud." This is rather a bold statement, as no one has ever observed, or recorded, these insects actually depositing an egg in the body of an ant!

In 1906 Cobelli records that he discovered a colony of *Lasius fuliginosus* at Rovereto which was nesting in a willow tree, and on October 23rd, 1905, he observed the workers removing their larvae from the nest in the willow to a subterranean nest at the roots of the tree. A number of *P. cremieri* females were observed hovering over the ants, and he actually saw them lay their eggs in the ants' larvae as they were being carried! A *Pachylomma* never touched an ant which was not carrying a larva, but he counted over twenty times when they did lay in the larvae, and could have continued the observation indefinitely.

In 1907 de Gaulle recorded "*Pachylomma*, Bréb., *buccatum*, Bréb.," in France with *Lasius brunneus* and *Myrmica scabrinodis*, and *P. cremieri*, Rom., with *Lasius fuliginosus* and *Formica rufa*.

Morley (1909) in some notes on *Pachylomma*, etc., pointed out that there is a specimen from Birch Wood in Marshall's collection, and that he (Morley) possesses two examples, one captured at Greenings, near East Grinstead, in July, 1872, by Wilson Saunders, and the other by himself on his study window, in Monks Soham House, Suffolk, on July 1st, 1905.

In 1909 Donisthorpe recorded that he met with *Paxylomma buccata*, Bréb., at St. Helens, I. of Wight, on July 29, "hovering over a nest of *Lasius niger* and striking at the ants in the usual manner."

On July 9th, 1911, the same author found this species in numbers near Rame Head, Cornwall. A large nest of *Lasius niger* occurred under a very big heavy stone, and the Braconids were hovering over the ants around the edges of the stone where the latter entered the nest. In the same year Taylor and Crawley observed it hovering over the last-mentioned ant at Sandown, I. of Wight.

On July 12th, 1912, Donisthorpe captured specimens of *P. buccata* which were hovering over the ants in a nest of *Formica rufibarbis* at Weybridge; and on July 18th he dug up a specimen in a nest of *A. (D.) alienus* in the same locality.

Very large specimens of *P. buccata* were taken by the same author on June 29th, 1913, in Parkhurst Forest, hovering over workers on a nest of *Formica rufa* var. *rufopratensis*, and on July 29th he observed typical specimens at Weybridge hovering over workers of *F. rufibarbis*, *F. sanguinea*, *A. (C.) flavus* and *Tapinoma erraticum*.

In June, 1913, a number of specimens of *P. buccata* were bred out in an observation nest of *A. (D.) alienus*. The ants and brood to occupy this nest had been taken at Weybridge by Donisthorpe on July 10th, 1912. He concluded that the parasites had evidently emerged from the bodies of their hosts as larvae, for he found their naked pupae lying among the ants' cocoons, and at first he thought they were naked male ant pupae.

In 1913 Haupt described a new genus and species of PAXYLOMMATINAE—*Ogkosoma schwarzi*—from four specimens taken by H. F. Schwarz at Halle on October 8th, 1912. These insects were swarming and hovering over, and in and out of, a hollow in a large oak trunk. It is most probable that the tree was inhabited, either by *A. (D.) fuliginosus* or *A. (D.) brunneus*.

On September 18th, 1929, Donisthorpe observed several specimens of a large *Paxylomma* in Windsor Forest. Two of these were captured, and proved to be the fine new species here described by Wilkinson under the name of *P. fuliginosi*.

The Braconids were hovering over the ants from a colony of *A. (D.) fuliginosus* inhabiting a large felled larch tree. The tree was being cut into sections, and the ants were pouring out and running all over the trunk carrying their larvae. On a subsequent visit to the same locality, on October 1st, another specimen was secured.

CONCLUSION.

In the present state of our knowledge it is not possible to give a complete account of the life-histories of these very interesting Braconids. Indeed the habits of some of these species can only be presumed by comparing them with those whose behaviour is better known.

It has been suggested that they are parasitic on a cockroach, a beetle, an Aphid, and on ants. The two first suggestions may be dismissed at once. It is also very probable that the third is equally unlikely; but that they are parasitic on ants in some way has undoubtedly been proved.

In the case of *Paxylomma cremieri*, Cobelli actually saw this species laying its eggs in the ants' larvae when they were being carried by their nurses. It is very probable that the same habits are common to *P. fuliginosi*, as it was not until the tree which housed the ants was being cut up that the Braconids

put in an appearance. They were probably attracted by the odour given off by the ants when agitated, as well as by the presence of the larvae which they were carrying.

It was concluded for *P. buccata* (and perhaps naturally so, considering the known habits of the Braconid, *Elasmosoma berolinense*, Ruthe)* that this Hymenopteron hovered over ants to lay an egg in their bodies. Giraud said it made pounces at the ants, and I have recorded it "striking at the ants," over which it was hovering.

As the ants *A. (D.) niger* and *A. (D.) alienus* are subterranean in their habits, if the *Paxylomma* are to lay eggs in their larvae, they would have to go beneath the ground to do so. On the occasion when I observed *P. buccata* hovering over the ants around the edges of a large stone where the latter entered their nest, it would not have been difficult for the former to gain access in the same manner.

Again, when specimens of *P. buccata* were bred out in my *alienus* observation nest, their naked pupae were in the same chamber as the ants' pupae in cocoons. I suggested that they had come out of the ants' bodies as larvae before pupating; but in that case one should have found them in the refuse chamber with dead ants, etc. It is possible that they entirely devoured the larvae in which they had fed up and changed to pupae at the same time as the uninfested ants' larvae spun their cocoons. Further observations in the field and experiments in the laboratory are necessary before these points can be satisfactorily cleared up.

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* See Donisthorpe, *Guests of British Ants*, 1927, p. 89.

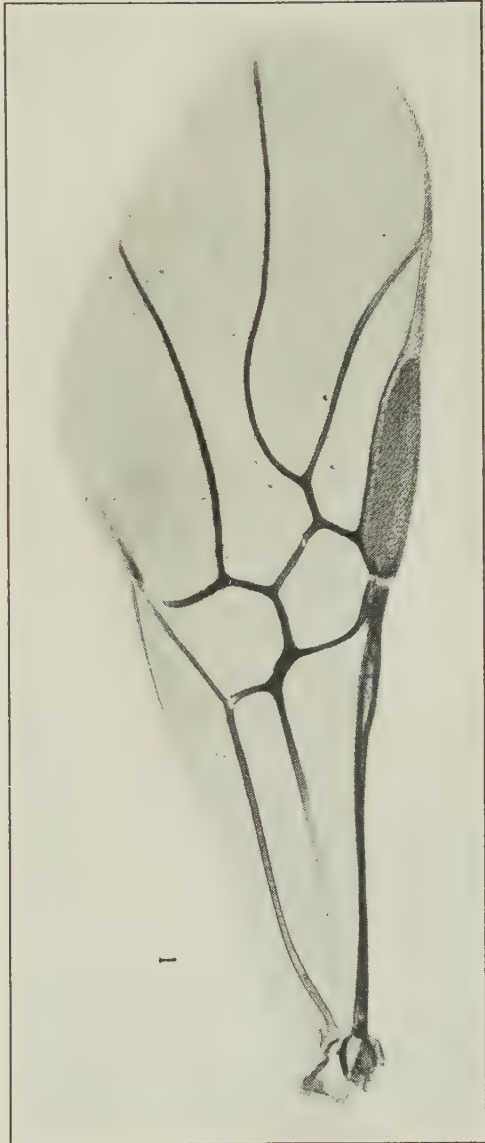


Fig. 1. *PAXYLOMMA CREMIERI*, Rom.
Fig. 2. *PAXYLOMMA FULIGINOSI*, sp. n.
Fig. 3. *PAXYLOMMA BUCCATA*, Bréb.

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THE BIOLOGY OF THE BRITISH FOSSORIAL WASPS OF THE FAMILIES MELLINIDAE, GORYTIDAE, PHILANTHIDAE, OXYBELIDAE, AND TRYPOXYLIDAE

By A. H. HAMM, A.L.S., and O. W. RICHARDS, M.A.

[Read December 4th, 1929.]

WITH A TEXT-FIGURE.

IN the *Trans. Ent. Soc. Lond.*, **74**: 297-331, 1926, was published an account of the biology of the British CRABRONIDAE. The present paper is a continuation of that work, and deals with about half the remaining species of British Sphecoids. As in our previous paper we have endeavoured to collect together all that continental observers have recorded of the habits and parasites of British species.

The identification of the Sphecoids and of the bees captured by *Cerceris* was, in the early stages of this work, due to the late Mr. E. Saunders, F.R.S.; the more recent material we have determined ourselves. As before, in the identification of the prey, we have received much kind help. The following gentlemen, each of whom is indicated by his initials in the third column of the list at the end of the paper, gave us help in dealing with particular orders:—*Diptera*—the bulk of the specimens Mr. J. E. Collin, a few, however, by Major E. E. Austen, the late Col. J. W. Yerbury, the late Mr. G. H. Verrall and Mr. P. Grimshaw; *Coleoptera*—Commdr. J. J. Walker and the late Mr. A. J. Chitty; *Homoptera*—the late Mr. E. Saunders; *Arachnida*—Mr. W. S. Bristowe, Dr. A. R. Jackson and Mr. F. B. Smith. The material dealt with is nearly all preserved in the Hope Department of the Oxford University Museum, and was mostly captured by the senior author; the following gentlemen, however, have also contributed specimens:—Dr. G. Arnold, Messrs. J. Balfour-Browne, W. S. Bristowe, the late Mr. A. J. Chitty, Messrs. J. Collins, H. M. Hallett, O. H. Latter, Sir G. A. K. Marshall, the late Rev. F. D. Morice, Dr. J. W. Munro, Dr. R. C. L. Perkins, Dr. Hugh Scott, the late Mr. F. W. L. Sladen, Mr. G. M. Spooner and the late Col. J. W. Yerbury. Dr. Hugh Scott has also been kind enough to allow us to include an account of certain specimens from the Cambridge Zoological Museum. To all these gentlemen we offer our heartiest thanks for the help they have so readily given.

Finally we owe a special debt to Prof. Poulton, who has placed the facilities of the Hope Department at our disposal, has allowed us to make use of his extensive manuscript notes on the literature of predacious insects, and who has given us every encouragement throughout the progress of the work.

In our previous paper we were able to give the sex of all the prey. In the present one, unfortunately, this has not been possible in the case of some of the beetles. The sex of the prey did not seem a point sufficiently important to justify spending many hours in dissecting the dried specimens. Further, the general view of the prey of each species in each drawer in the Hope Department would be much obscured if a large part of the prey were considerably damaged.

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MELLINIDAE.

1. *Mellinus arvensis*, L.

The habits of this common wasp have been known in more or less detail for a long time. The earliest account appears to be that of Réaumur (1747) based on the observations of du Hamel at Nainvilliers. He describes the more or less gregarious nesting in sand, and notes that when excavation is finished, flies are brought in for the larva. He supposed that the larva was fed from day to day by the mother. This progressive provisioning has also been affirmed by Schenck (1857, p. 184), and Smith (1858, p. 113), who state that the egg is laid on the first fly brought in and the larva afterwards fed daily. Verhoeff (1892) and Adlerz (1903), however, have shown that daily feeding, if it occurs at all, is quite exceptional.

By far the best general account is that of Adlerz (1903, pp. 56-65). In Sweden the wasps first appear rather before the middle of July and are found till the late autumn. The female hunts for flies mainly about dung, but also on the leaves of trees, etc. As a rule she alights some distance from the dung and crawls towards it, stalking some seated fly. Her antennae are stretched straight forwards, and when she is within about 2 cm. of the fly she springs from her crouching position to alight on the back of her victim. The majority of her attacks are successful. The fly's wing is held in the wasp's mandibles while the fore-legs seize the body, the abdomen being bent round to sting the fly beneath the thorax. Then, still transfixed on the sting, the fly is turned over, the proboscis gripped by the mandibles and the sting withdrawn. If the fly's proboscis is retracted, the wasp will try to force it out; if the head is split in the process and the fly killed outright, it is rejected. The prey is now carried off to the nest, of which the first cell has already been prepared. The fly, still held by the proboscis, is carried in. If the prey is jerked away from it when just about to enter the burrow, the wasp at first stands dumbfounded, then enters. If the fly be now replaced with the proboscis cut off, the wasp will drag it in by the head, showing that the instinct to hold the proboscis is not absolutely unmodifiable.

The burrow, whose entrance is not rarely hidden by a leaf or a stone, is 30-50 cm. deep, with cells extending all round the main tunnel, from which they branch off at points situated from 2-10 cm. from the bottom. As each cell is stored the passage connecting it with the main tunnel is filled in. Four to nine flies are stored in each cell, the number, perhaps, being correlated with the sex of the occupant. Nearly all the flies lie in the cell with their heads pointing inwards, and usually only enough are stored to fill the cell two-thirds full. The egg is laid on one of the flies last brought into the cell; it is attached to the sternum, across which it lies diagonally, between the first and second pairs of legs. Sometimes the wasp omits to lay an egg, while less frequently two eggs are laid. In the latter case it is probable that one of the resulting larvae eats the other.

Owing to the fact that cells only partially stored never contain an egg or a larva, the species cannot feed its larvae from day to day as the early observers thought. It is a peculiarity of *Mellinus* that the full-grown larva is of a purplish colour. It spins a light-yellow, soft, parchment-like cocoon, surrounded by a loosely agglutinated layer of sand and the remains of the prey. The prey is mainly Muscid, the predominant species often being some fly that happens to be common in the locality. In one spot *Syrphus* [*Scaeva*] species were found to be an important part of the larval diet.

Many other authors have described some part of the nesting habits. Verhoeff (1892), who found the species nesting in a mud wall at Heidelberg on the 1st September, states that only one cell is made in each burrow. Chevalier (1924), Morley (1908) and Spooner (1928), however, as well as Adlerz, record nests of several cells, the first-named observer finding one of ten.

Chevalier (1924) found that the wasp brought the prey to the mouth of the burrow, put it down, then, walking backwards, dragged it into the nest by an antenna. A female was caught coming out of her nest and was put in a tube



Six females of *Mellinus arvensis*, L., photographed after death while still gripping their victims by the proboscis. (Shotover, Oxford.)

with a fly. She dashed at it and stung the fly under its neck, then seized it by an antenna and attempted to escape. These observations, which were made near Paris, were repeated several times. Other authors, *e.g.* Steinvorth (1867), Sickmann (1891) and Thijssse (1914), also personal observations of A.H.H., find that it is the proboscis of the fly that is seized in the wasp's mandibles. At Oxshott, Surrey, the wasp has been seen (O.W.R.) flying with the prey held in the same way, the two anterior legs supporting the fly's body, as also Goureau (1839) records. Morley (1910) saw one *Mellinus* carry its fly upside down, while another was carried the right way up with the mandibles gripping the proboscis of the dislocated head. Wasps still holding their prey in this way are preserved

in the Hope Department of the Oxford University Museum. Spooner, however, (1928, p. 64), speaks of the fly being held round its neck. It would be very interesting if there was really local variation in this instinct.

The prey is frequently sought for on dung as Smith (1849 and 1858), Kohl (1880), Alfken (1915) and Bristowe (1927) record. The wasp waits motionless for flies to appear and then pounces on them from a few centimetres distance, just as a cat does on a sparrow. Besides, Adlerz (1903), Rabaud (1917) and Bristowe (1927) have described the method of stinging. The wasp is always seated on top of the fly and bends her abdomen round to sting the underside of the anterior part of the thorax. Ferton (1899, p. 14) found that paralysed flies lived for a very short period only. Spooner (1928, p. 65) found that many of the prey remained fresh, though without power of movement, for a week, while two specimens were fresh after a fortnight had elapsed, when they too dried up.

The nest is usually made in sand which is not covered by vegetation. Sometimes the bare patches round rabbit burrows are used (*cf.* Shuckard, 1837, p. 205). Nearly always several nests are found together.

Rabaud (1917) has made some interesting observations on the instincts of *Mellinus*. The wasps were kept in captivity in glass tubes, and the irregularities of behaviour due to this unnatural environment throw much light on the normal behaviour.

The prey is sometimes eaten at once, no endeavour being made to take it to the nest. (This has also been noted by Chevalier, *loc. cit.*, and by A.H.H.) When this happens the wasp either bites off the abdomen or the head, eating out the contents of the thorax and, in the latter case, of the head also. The integument of the thorax is never damaged. The constancy of behaviour in paralysing the prey which most observers have recorded is due to the observations having been made in constant natural conditions. Under varied artificial conditions the behaviour varies, which suggests that instinct is not so innately fixed as has been supposed.

The female *Mellinus* was put in a glass tube of 7–8 mm. diameter, and a fly was added. In most cases the attack and the paralysation were just as they have been described under natural conditions, though the fly was often eaten immediately. In a certain number of cases the first sting on the underside of the neck was repeated a little posteriorly. The behaviour was quite deliberate and precise. In other experiments, however, owing to the confined space the wasp gripped its victim awkwardly, sometimes on the ventral surface. When this happened the abdominal movements were normal, but the sting was unable to pierce the dorsal surface and would slide off. Sooner or later, however, it penetrated one of the articulations of the legs or the base of the abdomen and paralysis would result. The movements of the wasp are thus controlled in all probability by its own structure, and it has no intuitive knowledge of the fly's nervous system. There is, as a matter of fact, no need to pierce the actual nerve cord, for the poison soon takes effect by diffusion. Even when stung in the normal way the fly moves its more posterior parts for a short time till the poison has reached them.

When the wasp is attacking in normal conditions the movements of the sting appear to be directed towards a special part of the prey, so that when a sting in the correct spot has been given, the movements cease. Several abnormal conflicts show, however, that in reality no particular part of the prey is aimed at and that the movements go on till the fly stops struggling. Thus in one case when the pair were struggling, belly to belly, stinging movements went on as long as the fly was in contact with the wasp's sternum, but when the fly dis-

engaged itself so as to be held by the wasp's mandibles only, sting-movements stopped immediately, though the fly was quite alive, and the wasp at once chewed it up. In another case after a confused fight the fly came to be lying at right angles to the wasp, which held the thorax of its victim in its mandibles and the head and abdomen with its front legs. There was thus no contact between the wasp's sternum and the fly, no stinging movements were made, and the fly was simply eaten.

The number of stings given depends on the length of time the fly struggles, so that in a normal encounter in which the relative positions of the combatants are adapted to the size and structure of the wasp one sting alone will suffice. In some of the struggles on the other hand, when the fly was held awkwardly, the sting only glided off the fly. Under such conditions as long as the fly tries to escape the wasp bends its abdomen and stings; if the fly rests for a time, then stinging movements also cease.

Thus it would appear that stinging is a reflex action called into play by the contact of a fly with the wasp's sternum and continuing till movements of the prey cease. Under normal conditions the reflexes attain their end so perfectly that the wasp appears to be acting with a conscious purpose.

Thijssse (1914) has published an interesting record of the careful survey made of the nesting-site when the latter is first adopted.

Parasites.—Adlerz (1903) notes that larvae of parasitic flies are often found in the nests. At Oxshott, Surrey, 28 Dec., 1925, a puparium was found (O.W.R.) in the sand amongst fly remains in a spot where *Mellinus* had nested commonly in the autumn. It produced on 13 June, 1926, a female of the Tachinid fly *Macronychia griseola*, Fall. (but cf. remarks under *Oxybelus uniglumis*, L., p. 116). At Oxshott, also, on 6 Sept., 1924, the Tachinid *Sphecapata conica*, Fall., was found (O.W.R.) commonly shadowing females of the wasp laden with prey. It is probably the commonest parasite.

The following species of flies have been recorded as prey :—

- Kirby & Spence (1815, p. 255), *Stomoxys* [*Musca*]* *calcitrans*, L.
 Curtis (1836, pl. 580), *Calliphora* [*Musca*] *vomitaria*, L.
 Goureau (1839, p. 542), *Musca autumnalis*, De G. [*corvina*, F.] (at Collonges).
 Dahlbom (1843, p. 227), *Pollenia* [*Musca*] *rudis*, F. (in Norway).
 Schenck (1857, p. 184), *Pollenia* [*Musca*] *rudis*, F. (at Nassau).
 Lucas (1867, p. 293), *Pollenia rudis*, F., *Scatophaga scybalaria*, L. (at Ouistreham, Normandy, in August).
 Kohl (1880, p. 231), *Dasyphora pratorum*, Mg., *Musca autumnalis*, De G. [*corvina*, F.], *Myiospila mediatubunda*, F., *Orthellia* [*Lucilia*] *cornicina*, F., *Pollenia rudis*, F. (in Tyrol).
 Sickmann (1891, p. 90), *Hylemyia strigosa*, F., *Onesia sepulchralis*, Mg., *Pollenia rudis*, F. (at Iburg).
 V. R. Perkins (1892), *Calliphora* (Gloucestershire).
 Verhoeff (1892, p. 696), *Pollenia rudis*, F., *Tephritis* sp. (near Heidelberg).
 Morley (1896, p. 182), *Syrphus ribesii*, L. (near Ipswich).
 Adlerz (1903, p. 64), at least 20 species amongst 264 specimens. *Haematopota pluvialis*, L., *Hydrotaea* [*Anthomyia*] *irritans*, Fall., *Hylemyia variata*, Fall. [*Anthomyia rustica*, R.-D.], *Neuroctena* [*Dryomyza*] *anilis*, Fall., *Orthellia* [*Lucilia*] *cornicina*, F., *Polietes* [*Aricia*] *lardaria*, F., *Pollenia rudis*, F.,

* When the generic or specific name used by the actual observer is not now in general use, the correct name is given and that originally employed is added in square brackets.

- Syrphus* [Scaeva] *ribesii*, L. (in southern Sweden). Nearly half the specimens were the *Orthellia*, while *Pollenia* and *Hydrotaea* were very common.
- Morley (1910, p. 144), *Ceromasia spectabilis*, Mg., *Hylemyia*? *strigosa*, F., *Lucilia caesar*, L., *Onesia* "sepulchralis," L., *Orthellia* [*Euphoria*] *cornicina*, F., *Phyto melanocephala*, Mg., *Pollenia rudis*, F., *Sarcophaga melanura*, Mg., *Scatophaga stercoraria*, L., *Spilogaster* sp., *Syrphus balteatus*, L. (Lowestoft, 19 Aug. 1908).
- Thijssse (1914, p. 53), *Scatophaga stercoraria*, L., exclusively (Holland).
- Alfken (1915, p. 280), *Muscina pascuorum*, Mg., *Orthellia* [*Pseudopyrellia*] *cornicina*, F., *Pollenia vespillo*, F. (N.W. Germany).
- Fahringer (1922a, p. 180), *Anthomyia*, sp. (Bithynian Olympus, Asia Minor).
- Chevalier (1924, p. 62), *Lucilia caesar*, L., *Orthellia* [*Lucilia*] *cornicina*, F., *Phaonia querceti*, Bouché [*Mydaea platyptera*, Zett.], *Pollenia rudis*, F., *Sargus cuprarius*, L. (near Paris).
- Spöcner (1928, p. 65), *Hydrophoria conica*, Wied., *Musca autumnalis*, De G., *Orthellia* [*Euphoria*] *cornicina*, F., *Pollenia rudis*, F., *Pyrellia cadaverina*, L., *Scatophaga stercoraria*, L., *Spilogaster* [*Hyetodesia*] *lucorum*, Fall., *Spilogaster* [*Hyetodesia*]? *marmorata*, Zett., *Voria*? *ruralis*, Fall. (Warmwell Heath, Dorset, 4 Oct. 1927).
- Arnold (in litt.), small black flies and Syrphids, often mixed (Wimbledon, July 1904).

In the present paper 205 specimens of prey are recorded, mostly MUSCIDAE s.l., 106 females and 99 males.

1a. *Mellinus alpinus*, Handl.

This form is either a variety of *M. arvensis*, L., or else so closely allied a species that, though not British, its habits are worth giving for comparison. Handlirsch (1895, p. 841) has already recorded Kohl's observations made at Ratzes, S. Tyrol. The wasp was nesting in a slope with an angle of about 45°, the tunnels being $\frac{3}{4}$ cm. in diameter. In the absence of the owner the nest was often left open. Each nest consisted of a terminal cell and apparently several lateral ones, each containing about seven flies, which were carried straight in without any reconnoitring. The wasp's egg is laid between the first and second legs of the prey and is inclined up its pleuron so as to reach the wing-base.

About eighty of the prey were taken and identified as follows:—*Acalyptrates* two, *Anthomyia*, *Calliphora*, *Dasyphora pratorum*, Mg., *Fannia* [*Homalomyia*], *Gymnodexia triangulifera*, Zett., *Leptis*, *Muscina* [*Cyrtoneura*], *Myiospila mediatubunda*, F., *Onesia*, *Paramacronychia*, *Parexorista antennata*, Br. & Berg., *Phaonia* [*Aricia*], *Zenillia pullata*, Mg. [*Phorocera polleniella*, Rdi.], *Phryxe* [*Blepharidea*], *Pollenia atramentaria*, Mg., *P. rudis*, F., *P. vespillo*, F., *Sarcophaga*, *Lydina aenea*, Mg. [*Somoleia rebaptizata*, Rdi.], *Spilogaster*.

In the Hope Department are the flies captured by three females of *M. alpinus*, as follows:—*Paramacronychia flavipalpis*, Girschn., ♀, (det. J.E.C.) Schlern, Seiser Alpe, Italian Tyrol, 2 Aug. '94, H. Friese, specimen presented by the Rev. F. D. Morice. *Pollenia atramentaria*, Mg., ♂, and *P. rudis*, F., ♀, Seiser Alpe, 30 Aug. '25, O.W.R.

This second appearance of the rare Tachinid *Paramacronychia* is very interesting, for it belongs to a group normally parasitic on bees and wasps. It is quite probable that *Mellinus* is its as yet unrecorded host.

2. *Mellinus sabulosus*, F.

There is not much recorded of the habits of this insect. Lucas (1861) found it nesting in a sandy slope bordering a road near Havre, the burrows being detected by the small cones of excavated earth. According to Lucas some of the wasps had the yellow bands of the third and fourth abdominal segments entire, and these individuals captured slightly different prey from the other members of the colony, viz. *Orthellia* and *Syrphus*. Berland (1925) has re-examined Lucas's specimens and finds that though there is a slight intermixture of *M. arvensis*, L., the bulk of the specimens belong to *sabulosus*. The suggestion of a difference in habit within the members of the colony remains, however, doubtful. The prey was hunted on the flowers of *Daucus* and was held by the mandibles while the abdomen was bent round and the sting pierced the sides of the thorax or the abdomen. The victim was paralysed, and if taken from the wasp would live for about six weeks, though unable to walk. Adlerz (1903, p. 57) comments on the remarkable fact that paralysed Diptera should live so long (cf. *M. arvensis*).

The burrows were about 4 mm. broad and 5–6 cm. deep, always more or less curved in the middle. Twelve to fifteen flies were stored in one nest.

In England the wasp is local and mainly coastal; the nesting habits have not been observed.

Prey:—

Lucas (1861, p. 219), "*Anthomyia fuscipennis*, Macq.," *Chortophila cilicrura*, Rdi. [*Anthomyia cana*, Mcq.], *Coenosia tigrina*, F., *Myiospila* [*Curtoneura*] *meditabunda*, F., *Orthellia* [*Lucilia*] *cornicina*, F., *Syrphus corollae*, F. (near Havre).

Fahringer (1922a, p. 180), small black flies (nesting in sand at Poln Tschifflik, Asia Minor).

NYSSONIDAE.

3. *Harpaetus tumidus*, Pz.

This species, which always seems to be rather uncommon in England, nests in sand. Some account of the habits is given by Adlerz (1903, p. 55), who found it quite commonly at Sundvall, Sweden, from the end of June to the end of September. The entrance of the burrows was always closed with sand while the wasp was away hunting. Bringing the prey back the wasp usually flew, but one female combined walking and flying. The prey consisted of adult leaf-hoppers. Bouwman (1927, p. 55) notes that five to six are stored in each cell. Trautmann (1927, p. 58) records the Chrysid, *Hedychridium roseum*, Rossi, as a parasite. Two species of *Nysson* (q.v.), *N. maculatus*, F., and *N. dimidiatus*, Jur., are also parasitic on the wasp.

Prey:—

Kohl (1880, p. 231), "Cicadines," i.e. Jassids (Bözen).

Adlerz (1903, p. 55), *Acocephalus albifrons*, L., and *A. bifasciatus*, L. (Sundvall).

Perkins (1923, p. 41), larvae of *Philaenus spumarius*, L. (Devonshire, commonly).

Bouwman (1916, p. 6, and 1927, p. 55), *Acocephalus serratulae*, F., five to six females in each cell (Holland).

In the present paper one specimen of prey is recorded, a female Jassid.

4. *Gorytes mystaceus*, L.

One of the earliest accounts of the habits of this species is contained in some pencil notes by Prof. J. O. Westwood on pp. 212-13 of his copy of Shuckard's "Essay on the Fossorial Hymenoptera" in the Hope library. The notes are as follows:—"End of June, 1837. Observed *G. mystaceus* female flying very leisurely over *different* plants in search of food for her progeny. She at length found a patch of Cuckoo-froth. She protruded her legs and sting into this, but without success. Subsequently I saw her do the same in a drop of water which she evidently mistook for Cuckoo-froth. Again she tried in another patch of Cuckoo-froth without success, but soon after I saw her with a larva of *Aphrophora spumaria* which she carried beneath her body by the middle legs. 5th June, 1841. Again observed the female carrying a larva of *Aphrophora* using her middle legs to support it whilst walking."

Parasites.—*Nysson spinosus*, Foerst. (q.v.).

Prey.—Apparently always the larva of *Philaenus (Aphrophora) spumarius*, L., and probably of other species of the same genus, as recorded by:—

Shuckard (1837, p. 213), entering a sandbank with a larva.

Westwood (1840, p. 196), preying on the larva.

Ferton (1901, p. 106), female in the first days of May seen hunting in Algeria, running up and down grass-stems and plunging her head into the froth made by some leaf-hopper, finally extracting the larva.

Bristowe (1925, p. 278), larva at Cobham.

5. *Gorytes campestris*, Muell.

The best account of the habits of this wasp is given by Adlerz (1903, p. 35, and 1906, p. 30). The species was found nesting in several places on bare slopes of either clay or gravel in South Sweden. In each case the wasp *Hoplomerus spinipes*, L., or *H. reniformis*, Gmel., was found nesting in closely adjacent colonies. These two wasps are very much like *Gorytes* in colour and look very similar when flying. Handlirsch (1889, p. 326) has already noted parallel cases of colour resemblances between forms allied to the above species but occurring in S. America. The *Gorytes* was seen fetching its prey from cuckoo-spit on clover stems. The *Hoplomerus* also visits cuckoo-spit, but only to obtain liquid to build her "chimneys." There is a difference in the way the two wasps approach the froth, for the *Hoplomerus* flies straight to it, while the *Gorytes* alights on the stem and crawls up towards it. In the case of the latter the female then plunges her legs and sting simultaneously into the foam. The larva often falls to the ground and a successful capture was never actually witnessed. The prey is carried on the wing, sternum to sternum, supported by the mid legs. The burrow, which penetrates 10 cm. vertically and the same distance horizontally, is always left open while the mother is away. Each nest has six to nine cells. In one nest the average number of prey per cell was twenty-seven, in another only nineteen. One nest, in its early stages, ended in a single cell containing thirty *Philaenus* nymphs and a number of parasitic fly larvae. In all these nests the prey lay with their heads pointing inwards. In none of the cells was either egg or larva found, though these may have been overlooked; it is also possible that the female was consistently omitting to lay an egg, as sometimes happens in *Mellinus* and *Cerceris*.

Parasites.—*Nysson spinosus*, Foerst. (q.v.), and Adlerz (1906), "*Milto-gramma*," i.e. probably *Sphecapata conica*, Fall.

Prey.—Probably always the larva of *Philaenus* sp. Shuckard (1838, p. 215), Adlerz (1903, p. 35) and (1906, p. 30), and Ferton (1901, p. 105).

6. *Lestiphorus bicinctus*, Rossi.

Nothing appears to be known of the biology of this rare British species. *Nysson trimaculatus*, Rossi (q.v.), is perhaps a parasite.

7. *Hoplisus laticinctus*, Shuck.

Maillard (1847) found this species nesting in the earth of a flower-pot in his garden. The burrow was about 10 cm. long by 7–8 mm. wide, curved, and enlarged at the bottom into cells. It had stored larvae, apparently dead, of *Philaenus* [*Cercopis*] *spumarius*, L. Xamheu (1904) has described the larva, but gives no hint as to the habits of the adult.

8. *Hoplisus quadrifasciatus*, De G.

Nothing seems to be known of the biology of this species, though it is not uncommon in sandy places in the south of England. At Oxshott, Surrey, 9 July, 1924, it was found burrowing in the ground, but was not seen with prey (O.W.R.). *Nysson interruptus*, F., and *N. trimaculatus*, Rossi (q.v.), are parasites.

Nysson.

The species of this genus are parasitic on those of *Gorytes* (s.l.). Reinhard (1925, p. 172) has described the relation between the N. American *N. hoplisivora*, Rohw., and *Hoplisus costalis* (Cress.). The *Hoplisus* was nesting in sand and preying on Membracids. Whenever the wasp went hunting the burrow was closed with loose sand. The *Nysson* waited about the colony, sometimes entering open galleries containing the rightful owner, but then always retired hastily. As soon, however, as the *Hoplisus* leaves, the *Nysson*, after slight hesitation, rakes out the loose sand, enters quickly and comes out very soon, reclosing the nest. The returning mother is apparently unaware of what has been done. The host egg is fastened to the sternum of one of the prey, while the *Nysson* egg, which is only half the size, is slipped between an elytron and the abdomen of one of the prey. The *Nysson* egg hatches before that of the host, sometimes as much as twelve hours earlier, and the first, or almost the first, food of the parasitic larva is the host egg, which is not destroyed by the *Nysson* mother.

Adlerz (1906, p. 33) gives a very similar account of the relationship of *N. maculatus*, F., to *Harpactus tumidus*, Pz. In this case also the parasite's egg is laid under the elytron of one of the prey. Ferton (1901, p. 107) describes the behaviour of *N. dimidiatus*, Jur., to *Harpactus elegans*, Lep. The host nests at Bonifacio in June in sandy places. The *Nysson* wanders about the colony, often entering the nests in the absence of the owners, reclosing them after staying in some time. Excavation failed to show the egg of either host or parasite, and it is therefore probable that the *Nysson* was only making preliminary investigations. On one occasion a *Nysson* after uncovering the burrow of its host, flew up into the air and circled round several times. This locality study is probably necessary because the *Harpactus* spreads the sand it excavates

over 3-4 cm. all round the entrance, and the *Nysson* must be able to recognise the exact position of the orifice. *Harpactus*, as in the case of other parasitic Aculeates, recognises its enemy and chases it away at sight.

The hard integument and spinose thorax of the genus *Nysson* are found in many other parasitic Aculeates. At Bagley Wood, near Oxford, 14 June, 1924, a female *Tenthredo mesomelas*, L., was seen trying unsuccessfully to crush a male of *Nysson spinosus*, Foerst. (O.W.R.).

An examination of the records of the species of *Nysson* and *Gorytes* s.l. throws some light on the host-parasite relationship, for in certain districts only one, or a few species, of each genus occurs.

Malloch (1904), Dumbartonshire. *Nysson spinosus*, Foerst., and *Gorytes mystaceus*, L., were the only species of their genera in one glen. These two species also occur together abundantly in early summer in Bagley Wood, near Oxford (O.W.R.).

Saunders (1902), Alderney, Channel Islands. *N. trimaculatus*, Rossi, and *Gorytes campestris*, Muell., were the only species of their genera on the island.

At Oxshott, Surrey, the *N. trimaculatus* appears to associate with *Hoplisus quadrifasciatus*, De G.

Luff (1907), Guernsey, Channel Islands. *Nysson dimidiatus*, Jur., and *Harpactus tumidus*, Pz., the only species of their genera found on the island, were captured on the same spot on the same day. These two species have also been taken together as follows:—Shuckard (1837, pp. 104-5), both abundant on Hampstead Heath; Nevinson (1902), at Newquay; Stenton (1909), on Wimbledon Common; also at Oxshott, Surrey (O.W.R.).

In the following records the authors quoted have definitely associated the pairs of species together.

9. *Nysson spinosus*, Foerst., with *G. campestris*, Muell., Adlerz (1910, p. 38); with *G. mystaceus*, L., Perkins (1919), Bouwman (1927, p. 92) & Stelfox (1927, p. 305); doubtfully with *Hoplisus 5-cinctus*, F., Fahringer (1922a, p. 181).
10. *Nysson interruptus*, F., bred from rotten wood at Plymouth by Bignell, Saunders (1896, p. 110); caught round colonies and entering burrows of *Gorytes campestris*, Muell., Perkins (1923, p. 42).
11. *Nysson trimaculatus*, Rossi, parasite of *Hoplisus quadrifasciatus*, De G., Perkins (1919).
12. *Nysson dimidiatus*, Jur., parasite of *Harpactus tumidus*, Pz., Perkins (1919) and Bouwman (1927, p. 92); of *H. elegans*, Lep., Ferton (1901).
Nysson maculatus, F., of *Harpactus tumidus*, Pz., Adlerz (1910, p. 33).
Nysson hoplisivora, Rohw., of *Hoplisus costalis* (Cress.), Reinhard (1925).

It must be added that at Oxford, where *Harpactus tumidus*, Pz., is rare, *N. dimidiatus*, Jur., has several times been seen (A.H.H.) about the burrows of *Lindeniis albilabris*, F. This relationship requires further investigation.

13. *Didineis lunicornis*, F.

Ferton (1911, pp. 404-6) found this wasp in the first fortnight of October, near Algiers, on a bank of sand at the edge of the road. All the burrows were dug in the sides of holes made by the hooves of cattle, the tunnels running 2-3 cm. horizontally, then 15-20 cm. almost vertically, ending in an oval cell with smooth sides. The prey was nymphal and adult Homoptera:—*Agallia venosa*, Fall., *Chiasmus translucidus*, M. & R., *Delphax pellucida*, F., *D. venosa*,

Germ., *Eupelix spathulata*, Germ., and *Thamnotettix coroniceps*, Kb. Henriksen (1921) records *Acocephalus striatus*, F., as the prey in Denmark.

In England the species is rare and confined to the south; it appears to be found, as a rule, running on the ground or at the roots of grass. In the New Forest, Hants., a female was captured (A.H.H.) running amongst sparse vegetation on a slight bank, while a male was caught near Oxford on the flowers of wild carrot (*Daucus*).

14. *Philanthus triangulum*, F. (= *apivorus*, Latr.).

The earliest record of the habits of *Philanthus* is probably found in Vergil (*Georgics*, IV, line 245):—

“ Aut asper crabro imparibus immiscuit in armis . . . ”

“ Or wasps infest the camps with loud alarms,
and mix in battle with unequal arms ” (Dryden).

Christ (1791, pp. 270-2), under the name *Sphex apifalco*, tells how this wasp catches honey-bees on flowers, more rarely on the wing; wild bees were also sometimes caught. Latreille (1799 and 1802) gives a fuller account. He found *Philanthus* nesting at the edge of a road near, now well within, Paris. The burrows were horizontal or slightly inclined, sometimes curved, and were up to a foot long. Excavation was carried out with the help of the mandibles. Honey-bees were captured on flowers and stung on the ventral surface between the thorax and the head or abdomen, death resulting in a few minutes. In their death agony the bees often exerted their tongues and these were eagerly licked by the wasp. Hunting was sometimes carried on right up to the hives. It appeared that each cell contained one bee only, and, judging by a dissection of the ovaries, five to six eggs were laid in each nest.

The bee-eating proclivities of *P. triangulum* have also been studied by Lucas (1867), Girard (1878), Pérez (1880), van Schermbeek (1901), Poulton in Saunders (1904, p. 607), Pic (1917), Meyer (1919), and Grandi (1926). Although the workers of the honey-bee are by far the most important prey, other bees are occasionally captured. Lepeletier (1825, p. 103) adds *Andrena*; Smith (1858, p. 186), females of *Andrena flavipes*, Pz. [*fulvicrus*, K.], and *Halictus zonulus*, Sm. [*zonatus*, Sm.]; Fahringer (1922a, p. 179), *Andrena extricata*, Sm.

Bouvier (1916) notes that early in the season both sexes live together gregariously in one burrow. These are probably the offspring of one female [cf. *P. punctatus*, Say, whose habits are described by Peckham (1905)]. The males may also dig themselves special short tunnels for shelter during rain. The burrows in which the female rears her young are exceptionally deep. Fabre (1891) records three feet and Bouvier (1900) one to two feet. The latter author notes how prone the species is to the theft of nests belonging to other individuals, and he suggests that this may be because of the great labour involved in digging so deep a burrow. While the wasp is out hunting the nest is normally closed with loose sand, perhaps to keep out these marauding individuals, but Bouvier (1900) found that in part of the colony on the sand-hills at Luc-sur-Mer the nests were left open, except at night or when invasion was threatened. It seemed that those nesting in the vertical faces of the sand did not trouble to fill in the burrow temporarily, probably because it would be difficult to sweep in sand from the outside in the usual way when the nest was on so steep a slope. Verhoeff (1892, p. 696) states that the cells all open directly out of the end of the main burrow. Bouvier (1900) adds that there are

eight to ten cells and that three such nests are made in the course of the season, his estimate thus far exceeding that of Latreille. Verhoeff records that two bees are put in each cell, the egg being fixed to the sternum of the second; Fabre (1891), however, states that the egg is laid on the first bee and the larva is then fed according to its needs. Fabre also describes how the bee is stung on the ventral side of its neck, the wasp afterwards biting ("malaxating") the thorax to cause the honey in the crop to exude through the mouth, where it is eagerly licked up. The prey is often killed merely for the sake of this honey and then discarded. Picard (1903) found the nest of one individual surrounded by the corpses of thirty or more bees. While finishing its excavations, the wasp would visit first one then another of these bees to malaxate the thorax and suck up the honey. Numerous ants were attracted to the plentiful store of provisions. This habit renders *Philanthus* very destructive, for the death of 100 workers is in itself enough to ruin a hive.

The stored bees are quite paralysed. Meyer (1919, p. 21) found that they recovered somewhat after four days, though never at all completely. Lepeletier (1841, p. 563) found that some of the bees would even survive for a fortnight. Fahringer (1922*b*) has made some experiments on the ability of *Philanthus* to distinguish between honey-bees and drone-flies, *Eristalis*. The wasp was observed near Vienna, and when it put down its prey just outside the burrow before dragging it in, the bee was removed and an *Eristalis*, stupefied with cyanide, was substituted. The wasp was never deceived, though similarly stupefied bees were readily accepted. This experiment was made with five or six species of *Eristalis* and on about thirty individuals of the wasp.

Parasites.—Latreille (1799), "Le Chrysis dorée" and the larva of *Dermestes murinus*, L. The Chrysid, *Hedychrum rutilans*, Dahlb., is recorded by Ferton (1910), Meyer (1919) and Trautmann (1927, p. 72). The first-named author notes how the parasite waits with its head towards the mouth of the burrow and enters after the female has entered with prey. Meyer and Trautmann also record *H. gerstaeckeri*, Chevr. Baer (1921) and Grandi (1926) record the Tachinid *Metopia leucocephala*, Rossi, and the former author also *Sphecapata conica*, Fall. Kroeber (1925, p. 6) records the Conopid *Physocephala chrysorrhoea*, Mg., while Bouwman (1927, p. 116) records that *P. vittata*, F., emerged from the body of a wasp found dead in its burrow.

The history of *P. triangulum*, F., in England has been curious. It was first found rarely in Hampshire, afterwards commonly in the Isle of Wight; a little later a few specimens were taken in Kent, Surrey and Essex (see Smith, 1858, p. 188). Since these early records there has been only one capture recorded, a single male by Freke (1900) at Folkestone.

In the present paper one record of *Philanthus* with a honey-bee is noted from a French locality. Three of the honey-bees mentioned by Saunders (1904, p. 607) are also in the collection of the Hope Department.

15. *Cerceris rybyensis*, L. (= *ornata*, F., = *variabilis*, Schrk.).

The classical account of the behaviour of *C. rybyensis* is that given by P. Marchal (1887). His observations were made at Boron, Oise, France, where the species was nesting in his garden path. Here the hard soil was already pierced with innumerable holes by species of *Andrena* and *Halictus*, on which the wasp was preying. The *Cerceris* circled round the nests, every now and then dropping on the ground, or even entering a burrow. Only bees returning home laden with pollen were attacked, and these were knocked down as they

hovered over their nests just before entering. The wasp sat on the back of the bee which was held firmly by the neck and was stung two or three times under the thorax. The wasp maintained itself upright or leaning backwards supported by one hind leg; the other legs grasped the bee and the abdomen was bent upwards. The victim became motionless in a few seconds and the wasp then seized one antenna in its jaws, and, supporting the body with its legs, flew straight home to its burrow, which it entered without hesitation. This behaviour was witnessed many times without any variation, except that rarely the bee was held by both antennae, and that, when too heavy, it was carried to the wasp's nest in several stages.

The attacks of *Cerceris* in the wild state were not very commonly seen, and to study their behaviour in detail females just about to enter their nests with prey were captured and kept in bell-jars. In these circumstances, after wandering round for a time, the wasp re-stings its prey, and the process can then be watched very closely. It was found that the joint between the pro- and mesothorax was the point principally attacked. The bee, after being placed in the carrying position as already described, has its neck malaxated for three or four minutes. More rarely the malaxation is performed with the wasp still in the stinging attitude. When malaxation is over the prey is abandoned, though, in captivity, the wasp may repeat the process several times, in one case five times in two hours. After the first malaxation the bee is incapable of co-ordinated movements, but it does not seem that the paralysis is greatly intensified by repetition of the process. The malaxation appears to be a reflex action aroused in a female *Cerceris*, when on the hunt, by the sight of a *Halictus*. In nature it is carried out in the burrow and in captivity a short pause is made between stinging and malaxation, representing the time normally spent in returning to the nest with the prey.

In stinging, the grip of the mandibles on the dorsal surface of the neck stretches the underside of the head and thorax so as to leave crevices in the armour for the sting to penetrate. The parts most often stung are the neck and the articulation between the pro- and meso-thorax; large bees mainly in the former, smaller ones in the latter, or rarely between the thorax and abdomen. The wasp slides its sting up the ventral surface of the bee till some vulnerable point is encountered. There is no great precision, nor is there one point alone at which the attack can be made. If the neck of the bee be protected with gummed cardboard, it will be attacked elsewhere and paralysed just the same, the paralysis being apparently as complete as usual. The sting normally penetrates halfway between the ganglia, though the distance from one to another is very small.

The malaxation given is very severe and the skin of the bee is undoubtedly pierced, for the wasp's tongue can be seen entering and leaving the perforation. The process is almost certainly not directed towards the paralysis of the bee, but rather to feeding the wasp. The effect is to paralyse the antennae and mandibles completely and immediately, the legs still retaining some power of movement, and throughout the paralysis the tarsi keeping up rhythmical twitching movements. Similar tarsal movements can be seen in any bee lying with its feet not touching the ground, or in the *Cerceris* itself when sleeping on its side. The majority of the prey are dead in twenty-four hours and very few live longer than forty-eight. It was found that bees taken from the wasp after stinging but before malaxation, more or less recovered from their paralysis in four hours, sometimes enough to be able to stand up and vibrate their wings, though never recovering the power of flight. Gradually, however, they lose

their powers again and always die (in from one to twelve days), usually in about three days. It therefore follows that the *Cerceris* paralyses efficiently with the sting alone and the prey would then keep fresh longer than when malaxation is also performed, for it would remain alive for some time. Malaxated prey can be shown to die an early death, since such bees when taken from one cell keep equally fresh whether they have been chloroformed or not. The chloroformed specimens must certainly be dead. Bees which have been stung and malaxated appear to keep fresh longer than those which have been killed in various artificial ways, so the poison may, perhaps, have some preservative effect. In nature the wasp larva appears to be able to eat bees which have dried up to a considerable extent.

The burrow goes down 5–6 (rarely 8.5) cm. vertically and has a breadth of 6 mm. Its course is at first nearly vertical, gradually curving so as to become finally nearly horizontal. The total length of the burrow is thus 7–15 cm. It ends in an olive-shaped cell with its sides fairly carefully smoothed. Near this terminal cell are other lateral cells, the more (up to six to seven) the longer the nest has been occupied. Sometimes holes made by other insects are used. The number of bees stored is either seven to eight or four to five, perhaps depending on the sex of the prospective offspring. Some of the cells are stored with one species of bee alone and there is a tendency for individual wasps to specialise in one species, or at any rate size, of prey, though nests with several species mixed are quite common. The larval development lasts at least eight days.

It was found that, if the burrow of a *Cerceris* was stopped with sand while it was out hunting, on its return with a bee the prey would be abandoned after it had been laid down while the burrow was being opened up. When once the grip of the prey had been relaxed, it appeared no longer to be recognised. One wasp returned to its nest after the latter had been dug up. It continued bringing bees till enough had been brought to store the cell which it had been filling before the nest had been disturbed. It will be noticed that a large part of Marchal's observations are directed towards disproving some of Fabre's dogmatic statements.

Ferton (1905, p. 65, under the name *C. magnifica*) has also described the malaxation of the prey. Berland (1925, p. 54) found that the tongue as well as the neck may be licked, as in the case of *Philanthus*. Adlerz (1903, p. 66) found that the nest locality is memorised by a series of connected, semicircular flights, forming a zigzag a foot above the ground on one side of the nest. The wasp faces its nest the whole time and gradually moves farther away from it.

Parasites.—The Chrysid, *Hedychrum nobile*, Scop., is recorded by Alfken (1915a, p. 281) and doubtfully by Bridgman (1879) from Norfolk. Alfken (1899) also records *H. gerstaeckeri*, Chev., and the Tachinid fly *Metopia leucocephala*, Rossi [*argyrocephala*, Mg.]. At Tubney, Berks., the Chrysid *Hedychrum nobile*, Scop., and the fly, *Setulia grisea*, Mg., were found (A.H.H.) about the wasp's burrows. In this district *C. arenaria*, L., is absent.

Prey:—

Walckenaer (1817), *Halictus*; spp. not now recognisable (Château de Tautenville, Oise).

Goureaux (1834 and 1839, p. 542), *Halictus* females (at Collonges).

Shuckard (1837, p. 243), *Halictus leucozonius*, K., *H. calceatus*, Scop. [*fulvocinctus*, K.], and *H. rubicundus*, Christ (Battersea).

Dahlbom (1843, p. 201), *Panurgus ursinus*, Gmel. (Sweden).

- Schenck (1857, p. 145), *H. calceatus*, Scop. [*fulvocinctus*, K.], *H. leucozonius*, K., *H. rubicundus*, Christ, females (Nassau).
- Smith (1858, p. 189), *Halictus calceatus*, Scop. [*cylindricus*, F.], *H. rubicundus*, Christ, and *H. zonulus*, Smith, females (at Weybridge).
- Lucas (1867, p. 293), *Halictus calceatus*, Scop. [*abdominalis*, Pz.], and *H. ovatus* (this name is not now identifiable) (Lion-sur-Mer).
- Thomson (1874, p. 245), *Halictoides* [*Rhopites*] *dentiventris*, Nyl. (Sweden).
- Marchal (1887, p. 56), *H. albipes*, Sm., *H. tumulorum*, L. [*seladonius*, Lep.], *H. interruptus*, Pz., *H. minutus*, Zett., *H. sexcinctus*, Latr., and *H. subhirtus*, Lep. Males were common (Boron, Oise).
- Sickmann (1891, p. 94), *Halictus calceatus*, Scop., [*cylindricus*, F.] *H. leucozonius*, K., and *H. maculatus*, Sm. (Iburg).
- Borries (1897, p. 56), *Halictus calceatus*, Scop. [*cylindricus*, F.] (Denmark).
- Alfken (1899, p. 110), *Andrena fuscipes*, K., males commonly; *Halictus calceatus*, Scop., males; *H. leucozonius*, K., males commonly; and *Panurgus banksianus*, K., a few females (near Bremen).
- Adlerz (1900, p. 186), *Halictus* species, three to thirteen a cell, average six (Sweden).
- Ferton (1901, p. 109 and 1905, p. 65). In the second paper it is pointed out that in the earlier, two species had been confused. One of the species he here separates out, is named by him, *C. magnifica*. Berland (1925, p. 54) has shown, however, that Ferton's *magnifica* is only a form of *rybyensis*. Prey, females of *Andrena flavipes*, Pz. [*fulvicrus*, K.], *A. vetula*, Lep., *Halictus bifasciatus*, Pér., *H. cephalicus*, Mor., *H. cochlearipes*, Dours, *H. malachurus*, K., *H. scabiosae*, Rossi, *H. separandus*, Schmied. (at Bonifacio).
- Barnes (1902, p. 265), *Andrena argentata*, Sm. (at Wellington College).
- Alfken (1913, p. 42), *Halictus albipes*, F., males (near Bremen).
- Fahringer (1922a, p. 179), *Andrena* sp. (near Constantinople).
- Perkins (1923, p. 43), *Halictus leucopus*, K., *H. punctatissimus*, Schenck, and *H. tumulorum*, L. (Devon).
- Bristowe (1927, p. 9), females of *Andrena gwynana*, K., *Halictus calceatus*, Scop., *H. leucopus*, K., *H. malachurus*, K., and *H. zonulus*, Sm. (Cobham, Surrey).
- In the present paper 44 specimens of prey are recorded, 28 ♀ and 16 ♂.

16. *Cerceris emarginata*, Pz.

Ferton (1905, p. 65, and 1910, p. 153) and Grandi (1929, p. 267) are the only authors who have made a study of the habits of this species. Ferton enclosed a female in a glass tube when holding her prey by one (or perhaps by both) antennae. She soon dropped it, but later returned and stung it on the lower side of the neck. The upper surface of the neck was then sucked; the bee after this treatment was still alive. A nest at Escaffierels, 16th Aug., had a cell full of male and female *Halictus*, of which a *H. leucopygus*, Pér., carried the egg attached near the throat with the two anterior pairs of legs folded over it. The largest bee in this cell was a female of *H. malachurus*, K., and this was lying at the bottom of the cell, probably having been brought in before the others. It often seems to be the case that the first prey caught is the largest, perhaps because such a bee would keep longer. On 15th Aug., at Escaffierels, a female wasp entered carrying a female *H. mucoreus*, Ev., so much alive that it nearly escaped. Again, at Bonifacio, on 8th Sept., a *Cerceris* carried a bee

into a nest, which was immediately dug up disclosing the wasp with two females of *H. cephalicus*, Mor., both alive. Each bee had been walled off with a slight partition of sand, whose object is, perhaps, to keep out parasites while the mother is away, even though the outer entrance of the nest is also closed. In the latter stages of storing the nest smaller species of *Halictus* and of *Prosopis* are captured.

Grandi (*loc. cit.*) has recently studied the habits of *C. emarginata* in Italy. He found it in August nesting in very hard soil. The burrows descended approximately vertically and the cells were situated at a depth of from 7–12 cm. Their dimensions were 10 by 7 mm., and their number varied considerably, perhaps in accordance with the stage of construction the nest had reached. The maximum number found was twenty-four, but usually there were fewer than ten cells. The nests were stored with different species of bees of the genus *Halictus*, four to twelve (average 7.3) to a cell. In most nests a considerable proportion of the cell-contents had become overgrown with mould. When a cell appeared to be fully stored all the victims were completely paralysed, but in two cases, when a cell contained a single bee only, the victim was quite lively. It is possible it had not been malaxated before the nest was excavated. Both sexes of the bees preyed upon were captured, but apparently there was a tendency for the cells of any particular nest to contain mainly bees of one sex. Grandi also describes the larva and pupa of the wasp.

In England the wasp is very rare and the only record appears to be a single female taken at Deal in 1861 (Saunders, 1896, p. 118).

Baer (1921, p. 188) records the Tachinid *Setulia melanura*, Mg., as a parasite, and Grandi (1928, p. 271–2) the Chrysid, *Hedychrum gerstaeckeri*, Chevr., and the Tachinid, *Mitogramma* sp.

Prey :—

Ferton (1905, p. 65), *Andrena schenckella*, Pér., *Halictus albipes*, F., *H. aureolus*, Pér., *H. cephalicus*, Mor., *H. pauxillus*, Schenck, *Panurgus canescens*, Latr., *Prosopis clypearis*, Schenck (at Bonifacio).

Ferton (1910, p. 153), *H.* sp., male; *H. leucopygus*, Pér., seven males, eight females; *H. malachurus*, K., one small female; *H. morio*, F., one of doubtful sex (all in one cell at Escafferels). Also a female of *H. mucoreus*, Ev., in another nest at the same place.

Berland (1928, p. 175), *Epeolus productus*, Thoms. (Callian, Var, France).

Grandi (1929, p. 272), *Halictus atrovirens*, Pér., *H. fulvicornis*, K., *H. glabriusculus*, Mor., *H. maculatus*, Sm., *H. morio*, F., *H. quadrisignatus*, Sch., *H. simplex*, Pér., *H. tricoloratus*, Sch., *H. tumulorum*, L., *H. villosulus*, K. (Bologna).

17. *Cerceris arenaria*, L. (*laeta*, Pz.).

Adlerz (1903, p. 67) has best described the habits of this species. He found it nesting in the sandhills at Medelpad in Sweden in mid-July. More often than digging its own burrow it was appropriating those of the bee, *Trachusa serratulae*, Pz., whose nests were numerous in the sand. When once the main burrow had been made or stolen the wasp flew off to take the first prey, and after this has been captured about three-quarters of an hour must be spent in excavating the side passage and the first cell to which it leads. Most of the cells lie at a depth of 7 cm. and contain five to twelve, usually eight, weevils, in this colony nearly always *Brachyderes incanus*, L. In one case the weevil was thrown out during the later part of the excavation and was allowed to lie

sprawling on its back on the sand. It was able to make vigorous movements with its antennae and weak ones with its legs, movements which were, however, sufficient to enable it to walk away when it had been turned over. It died, however, after four days. At Oxshott, Surrey, 1 July, 1925, of seven weevils taken from a female *Cerceris* (O.W.R.), two showed no signs of life, three moved their antennae, one also the mouth-parts, and one also the legs. Grandi (1926) also notes that the prey can make slight movements. Although weevils are nearly always the prey, Lucas (1858) found a few specimens of the Eumolpid, *Bromius obscurus*, L., amongst many *Otiorrhynchus*. Chevalier (1927) records the method of stinging. The prey is seized by the thorax and stung centrally at the junction of the thorax and abdomen.

Grandi (1926, p. 290) notes that the female leaves the burrow open when she is away. One nest situated just under a lump of earth was made the subject of an experiment. It was found that when the lump was moved she searched for her nest at a spot about 1 cm. distant from the right place, but as soon as it was replaced she found her nest at once. Hartmann (1905, p. 66) observed that the landmark used by an individual of the American *C. fumipennis*, Say, was a small bush about two feet high; the female also appeared to approach the bush by taking a definite line between two more distant, tall trees. When the bush was cut down and removed the female could not find her nest, but was successful when it was replaced. Grandi (*loc. cit.*) found that the female reconnoitres the position of her nest by taking elliptical flights around it.

At Oxshott (O.W.R.) the males were found to pester the females when the latter were returning to their nests with prey. By clinging to their backs, the males made it impossible for the females to enter the burrows. The females got rid of the males by walking between two pine-needles and so scraping them off.

In England the wasp is restricted to sandy localities and is found mainly in the south.

Parasites.—The Chrysid, *Hedychrum nobile*, Scop. (*lucidulum*, F.), is recorded by Alfken (1915a, p. 282) and Trautmann (1927, p. 74); also somewhat doubtfully by Bridgman (1879) in Norfolk. Collin (1920, p. 307) records *Hammomyia grisea*, Fall, and Chevalier (1927, p. 100) *Metopia leucocephala*, Rossi. Hamm (1909; cf. also Wainwright, 1909) records the Tachinid, *Setulia grisea*, Mg. The female fly follows the prey-laden wasp, attempting to shadow it back to the nest. The wasp makes every effort to shake off its parasite by a dodging and twisting flight. The fly, however, always keeps 2–4 inches behind, following every movement of its host. When the *Cerceris* enters its burrow the fly waits outside, often for five to six minutes, entering the nest as soon as the wasp leaves and remaining for about a minute. The males of the wasp were never shadowed, though a female with prey might have two or three flies behind her. The same fly and wasp were found associated at Oxshott, Surrey (O.W.R.). Out of sixty-six female *Cerceris* captured with prey in the New Forest, twelve were followed by *Setulia*, and of these twelve two were followed by two flies each. At Esher Common, Surrey, 28 Aug., (A.H.H.) four out of twelve female *Cerceris* caught with prey were followed by *Setulia*. A curious case of mistaken parasitism was seen (A.H.H.) at Matley Bog, New Forest, 14 Aug. 1909, when a male of *Miltogramma punctatum*, Mg., a parasite of *Colletes*, was caught following a *Cerceris* with prey.

Prey:—

Kirby (1815, p. 388), *Otiorrhynchus* [*Curculio*] *singularis*, L. [*picipes*, F.], and

- O. [C.] raucus*, F. (quoting Ent. Bemerkungen [Hausmann], Brunswick, 1799, p. 6).
- Westwood (1836, p. 203), *Strophosomus* sp. When walking, the weevil was held by the rostrum in the wasp's mandibles; when flying, by the wasp's four anterior legs. Hampstead Heath, 24 July.
- Dahlbom (1843, p. 209), *Strophosomus faber*, Hbst. (at Silfakra).
- Lucas (1858, p. 399), *Bromius obscurus*, L. [*vitis*], *Otiorrhynchus nubilus*, Boh., *O. raucus*, F., *O. scabrosus*, Marsh., *O. sulcatus*, F., *Phytonomus punctatus* (at Fontenay-aux-Roses).
- Smith (1858, p. 189), usually *Strophosomus faber*, Hbst., but also *Balaninus nucum*, L., and *Otiorrhynchus sulcatus*, F.
- Thomson (1874, p. 246), *Strophosomus faber*, Hbst.
- Fabre (1879, p. 57), *Brachyderes gracilis*, Boh., *Cneorrhinus hispidus*, Boh., *Geonemus flabellipes*, Ol., *Otiorrhynchus malefidus*, Gyll., *Sitona lineata*, F., *S. tibialis*, Hbst. (in Provence).
- Kohl (1880, p. 226), *Brachyderes incanus*, L. (at Mühlau).
- Sickmann (1891, p. 94), small weevils, especially *Sitona lineata*, F. (at Iburg).
- Alfken (1899, p. 108), *Otiorrhynchus singularis*, L. [*picipes*, F.], *Strophosomus melanogrammus*, Foerst. [*coryli*, F.], *Tanymecus palliatus*, F. (at Bremen); also quotes Kohl, for *Brachyderes incanus*, L., *Otiorrhynchus mastix*, Ol., *O. sulcatus*, F., and *Tanymecus palliatus*, F. (at St. Paul).
- Adlerz (1903, p. 67), *Brachyderes incanus*, L., *Otiorrhynchus ovatus*, L., *Strophosomus melanogrammus*, Foerst. [*coryli*, F.] (Sweden).
- Hallett (1914, p. 57), entirely *Otiorrhynchus sulcatus*, F. (Horton, Glamorgan).
- Feytaud (1914 and 1918), *Otiorrhynchus sulcatus*, F. (France).
- Alfken (1915, p. 282), species in addition to his former list, *Cneorrhinus plagiatu*s, Schall. [*geminatus*, F.], *Otiorrhynchus morio*, F. [*unicolor*, Hbst.], *Lepyrrus palustris*, Scop., *Strophosomus capitatus*, De G. (Bremen).
- Fahringer (1922, p. 178), *Otiorrhynchus brevicornis*, F. (nr. Constantinople).
- Perkins (1923, p. 228), *Otiorrhynchus* and other weevils (Devon).
- Grandi (1926, p. 290), *Calostrophus subsulcatus*, Boh., *Sitona callosa*, Gyll., *S. lineata*, F., *Strophosomus melanogrammus*, Foerst. (nr. Bologna).
- Chevalier (1927), *Otiorrhynchus scabrosus*, Marsh., *O. sulcatus*, F., *O. ovatus*, L., *Peritelus griseus*, Ol. (8 to a cell. at Chatou, France).

In the present paper 366 specimens of prey are recorded and of those which have been sexed 72 are ♀ and 17 ♂. It was noticed at Oxshott (O.W.R.) that the nests of some of the individuals were stocked almost entirely with *Balaninus*, while other nests contained mainly *Strophosomus*. Further observations may show that there is a tendency for some of these wasps especially to attack either weevils on pines or on deciduous trees and shrubs.

18. *Cerceris labiata*, F.

There appears to be no detailed record of the habits of this species beyond a number of lists of prey. Smith (1858, p. 189) notes that it has a preference for the flowers of *Achillea*. Nielsen (1900, p. 267) records that it appears in Denmark later in the year than the other species, the female flying commonly in August, as is the case in England. He found it nesting in sand. At Fleet, Hants., it was found (A.H.H.) nesting in the vertical side of a sandpit.

Parasites.—According to Bridgman (1879) the Chrysid, *Hedychridium nobile*, Scop., may be a parasite.

Prey :—

Smith (1858, p. 189), *Longitarsus* [*Haltica*] *tabidus*, F.

Fabre (1879, p. 58), small weevils.

Adlerz (1900, p. 179), *Bromius* [*Adoxus*] *obscurus*, L., five in each cell (Sweden).

Nielsen (1900, p. 267), *Otiorrhynchus ovatus*, L.

In the present paper two specimens of prey are recorded.

19. *Cerceris quinquefasciata*, Rossi (*interrupta* of British authors).

According to Smith (1858, p. 189) this wasp nests in England in hard paths. Adlerz (1903, p. 70) found it burrowing at Nörrköping, Sweden, in the perpendicular walls of a sandpit. The weevils captured as prey were carried by the base of their rostrum, and, soon after capture, were often still capable of slight movements. Chevalier (1924, p. 77) has also studied the habits of a wasp which he calls *C. quinquefasciata*, but whose identity Berland (1925) considers somewhat doubtful, owing to the unusual nature of the prey, viz. *Crioceris*. The wasp was very unwilling to return to her nest while watched. The burrow was left open while the mother was out hunting, though it was closed for the night. A female, returning to her nest with prey, dropped it, but still went on into her nest as if she had retained it. Another female coming out of a burrow was put in a glass tube with this abandoned *Crioceris*, which was still making slight movements. After a time she perceived it lying on its back. She turned it over, stood over it so that the neck of the beetle touched her belly, and bent her abdomen so as to sting it under its thorax. The wasp then turned it over again, seized one antenna in her mandibles, supported the body of the beetle with her front legs, and started running about the tube.

More recently Grandi (1929, p. 276) has given additional details of the habits of this species. He found it on the 4th August nesting in hard ground. The entrance gallery was at first nearly horizontal, then descended vertically. In the nest excavated there were ten cells lying at depths of from 13–21 cm. The dimensions of the cells were 7 by 5–6 by 5 mm., and they were smooth inside. The prey consisted entirely of weevils, from 18 to 82 (average 50) to a cell. Grandi also describes the larva.

At Tubney, near Oxford, the wasp has been found (A.H.H.) nesting in fairly hard sand, sometimes in paths, often in company with *C. rybyensis*, L., and *Lindenius albilabris*, F. It has been seen to alight on a flower of *Scabiosa arvensis* and seize a beetle, *Meligethes*, in its mandibles.

Prey :—

Smith (1858, p. 189), *Apion rufirostre*, F.

Adlerz (1903, p. 70), 40 weevils in one cell, 38 *Apion*, especially *A. varipes*, Germ., one *Sitona sulcifrons*, Thunbg., and one *Tychius tomentosus*, Hbst. (at Nörrköping).

Harwood (1913, p. 230), *Strophosomus faber*, Hbst. (at Colchester).

Chevalier* (1924, p. 77), *Crioceris asparagi*, L. (near Paris).

Grandi (1929, p. 278), in a nest of ten cells, 249 weevils, 213 *Exapion compactum*, Desbr., 17 *Micrelus ericae*, Gyll., 17 *Sitona tibialis*, Hbst., 1 *Apion loti*, K. var. *fallens*, Desbr., 1 *Tychius junceus*, Reichb. (at Bologna).

In the present paper we record three female *Meligethes* as prey.

* Chevalier did not publish his observation until 1924, but de Gaulle (1904, Ann. Ass. Nat. Levallois-Perret 10: 15) records it twenty years previously.

20. *Cerceris quadricincta*, Vill.

Ferton (1905, p. 65) has given some account of the habits of this wasp. At Bonifacio it occurs commonly in spring and autumn, burrowing in clay or sand. It makes deep tunnels, which according to Fahringer (1921, p. 160) are 20 cm. deep and 4 mm. in diameter. The egg is laid on the venter of the prey in such a way that the head of the resulting larva lies near the anus of the weevil. Ferton (1910, p. 154) also found that when the first weevil has been brought in a barricade is thrown across the tunnel, and this is repeated for each of a few beetles next carried in. This appears to be a precaution of the wasp to keep out parasites, for in this genus the mouth of the nest is not closed in the mother's absence and several prey have to be brought in before the provisions for one cell are complete. Ferton has noticed the same behaviour in other species of *Cerceris* (cf. *C. emarginata*, Pz., on p. 110 of the present paper), and also in *Philanthus*.

Prey :—

- Fabre (1856, p. 184), *Apion pisi*, F. [*gravidum*, Ol.], about thirty to a cell, also sometimes *Phytonomus murinus*, F., and *Sitona lineata*, F.
 Ferton (1901, p. 109), *Apion tubiferum*, Gyll., *Bruchidius* [*Bruchus*] *bimaculatus*, Ol. [*variegatus*], *B.* [*B.*] *pusillus*, Germ., *B.* [*B.*] *caninus*, Kr. [*uniformis*, Bris.], *Colaspidia* [*Dia*] *oblonga*, Blanch., *Laria* [*Bruchus*] *atomaria*, L. [*seminarius*], *Peritelus foveithorax*, Desbr., *Phytonomus crinitus*, Schoenh., and *Sitona waterhousei*, Walt. (at Bonifacio).
 Ferton (1905, p. 65), *Apion pisi*, F., *Coeliodes erythroleucus*, Gmel. [*subrufus*, Hbst.], *Polydrosus cervinus*, L., *P. parallelus*, Chev. (at Bonifacio).
 Fahringer (1921, p. 160), *Lixus ascanii*, L., *Phyllobius* sp., *Stenorrhynchus* sp. (at Jarbaschi, Asia Minor).
 Chevalier (1927), *Anthonomus pedicularius*, L., *Erirrhinus filirostris*, Gyll. (at Chatou, France).

21. *Oxybelus uniglumis*, L.

A large number of observations have been made on the habits of this common wasp. The earliest appears to be that of Linné (1761, p. 418) : "Saepe tamen Muscam domesticam se triplo vel quadruplo majorem, occisam secum trahuit, uti Sphecx." *Oxybelus* begins nesting in early summer so that there are two or more generations in the year (Siebold, 1841; Borries, 1897). The burrow is always made in sandy soil, either level or sloping. Adlerz (1903, p. 42) finds that a special study of the nest locality is made either during or just after excavation. The wasp flies up and down above the nest, alighting at different points. The tunnel is 2-3½ inches long, ending in an oval cell, which, owing to the inclination of the burrow, is about 1½ inches below the surface (Siebold and Borries, *loc. cit.*). During the absence of the mother while hunting the nest is always closed. According to Latter (1913, p. 24) the prey is always hunted in the air, but Smith (1858, p. 162) records that the females run about grass-stems and catch flies that come to bask, pouncing on them like a cat. At Oxshott, Surrey (O.W.R.), *Oxybelus* has been seen attacking flies settled on pine stumps, catching them in the air, and also frequently taking those which were resting on the observer's hat, even when he was walking. There has been some controversy as to the exact way in which the prey is killed. The attack is so rapid and usually so immediately successful that it is almost impossible to see what really happens in the wild state. Wesenberg-Lund (quoted in Handlirsch,

1893, p. 687) states that the thorax of nearly all the flies he examined was damaged. This was because the wasp had laterally compressed it at the tegulae, so that in some cases torn muscle strands could be seen. This treatment, naturally enough, had killed the fly. Wesenberg-Lund's observations, however, require further confirmation. Sickmann (1883, p. 81) saw that the prey were stung on the lower surface of the neck and Chevalier (1926) has experimented with the wasp to find out how it really attacks its prey. This procedure was to grip the fly with a pair of forceps just as it was being drawn into the nest. The wasp released its prey and came out of the nest again and appeared to sting the fly in the neck. In another case the fly was taken from the wasp and laid on its back near the entrance. The wasp came out and stung it in the neck. Adlerz (1903), also, taking advantage of the fact that the sting remains inserted in the prey throughout the return journey, seized the fly as it was being taken in and was able to see that it had been pierced by the sting through the anterior part of the ventral side of the thorax. He even found that the wasp would sting flies that had been taken from it and were held in the air with the forceps. In a few cases the sting entered a little on one side of the middle line. All authors agree that the prey is carried impaled on the sting and trailing upside down behind the wasp, the fly's head nearly touching the wasp's tail. At the moment of entering its nest the wasp has to kick away the temporary sand barrier, and the fly is then raised in the air on the sting, while all the legs are used in the excavation (Latter, 1913). In flight according to Chevalier, the hind legs are also used in supporting the fly. This observation is confirmed (A.H.H.) by observations made at Oxshott, Surrey, in Aug. 1922.

Adlerz found that a wasp returning with prey was in no way confused if sand was thinly strewn over the nest, but a thickness of 1 cm. gave it some trouble. Stored in each cell are four to seven flies (Adlerz, Chevalier), or eight to twelve (Kieffer, 1902). They are arranged with their heads all pointing the same way, the egg being attached to the centre of the throat of the innermost (Adlerz, 1903). Latter (1913) records that six flies were caught in five minutes. Siebold (1841) found that some individuals stole the flies from other nests, but if the true owner returned it might reclaim its property. Kieffer (1902) found one cell, containing twelve *Fannia* [*Homalomyia*] *canicularis*, L., in which two eggs had been laid, an error of behaviour such as has already been noted in *Mellinus*. The cocoon (Chevalier) is about 8 mm. long, earthy, barrel-shaped and friable.

The prey do not as a rule show much sign of life, but Adlerz found one cell containing five flies but no egg (*i.e.* incompletely stored) in which all the prey could move their legs, and one its proboscis also.

Parasites.—*O. uniglumis* has a large number of parasites about some of which a good deal is known. One of the commonest is *Sphecapata conica*, Fall. Wainwright (1909) also records that the genus *Oxybelus* provides the most usual hosts of this fly. Siebold (1841) and Kieffer (1902) have studied its habits. The first-named author describes how *Sphecapata* waits round the nests and hovers behind females returning with prey. The wasp recognises it as an enemy and is very unwilling to enter her nest when followed by the parasite. The fly rushes into the burrow after the wasp and emerges in a very short period. The fly is viviparous, young larvae being extruded. Sometimes as many as three *Sphecapata* were seen following one *Oxybelus*, and several may wait round one nest. In such a case they do not fight but appear to take turns in oviposition. Kieffer notes that one to four puparia of the fly may be found in one nest. In one cell three full-grown larvae of this fly were found feeding on a dead full-

grown larva of *Oxybelus*. Dahlbom (1843, p. 273) and Adlerz (1900, p. 193) also record *S. conica* as a parasite.

Another common parasite is *Metopia leucocephala*, Rossi. Its habits are very similar to those of *Sphēcāpata*. Kieffer found that the fly did not enter the nest when the wasp was inside, but pounced on the prey just as it was being dragged in. Chevalier records, however, that only some individuals behave in the way described by Kieffer. Usually the *Metopia*, following the wasp into the burrow, allows herself to be shut up with it in the nest. The wasp will not go directly into the nest when the fly is present, but flies about the neighbourhood in zigzags. Sometimes she even puts the prey down to chase away the parasite, which may even be killed and may also, occasionally, form part of the prey. When the wasp puts down the prey for this purpose it may be stolen by ants, as at Oxshott (O.W.R.), when the robber was *Formica fusca*, L. Chevalier found that the wasp will pick up its prey with the ant still hanging on to it. The latter takes care not to let go till the wasp re-aliases. Chevalier (1926) also observed on one occasion that an *Aphiochaeta pygmaea*, Zett.,* entered an *Oxybelus* nest and allowed itself to be shut in with the prey. It is unlikely, however, that this fly can be a normal parasite (cf. Lundbeck, 1922, p. 396). The following species are also parasites of *O. uniglumis*.

Myrmosa melanocephala, F. Kieffer (1902); probably, Bouwman (1909, p. 285).
Smicromyrme [*Mutilla*] *rufipes*, Latr., Kieffer (1902), Alfken (1915a, p. 276) and Chevalier (1926).

Macronychia griseola, F. Kieffer (1902); we have already recorded (p. 99) this fly as a possible parasite of *Mellinus*, but since the host was in this case somewhat conjectural, it is possible that *Oxybelus* was the real host.

M. polyodon, Mg. Chevalier (1926).

Hammomyia albiseta, v. Ros. Chevalier (1926).

Kieffer (1902) also records three other Anthomyids (*Anthomyia pluvialis*, L., *Egle* [*Anthomyia*] *radicum*, L., and *Chortophila trichodactyla*, Rdi.). If Kieffer's observation was not due to some misunderstanding, these flies must have been behaving in a very aberrant manner (see the account of their habits given in Séguy, 1923). Alfken (1915b, p. 293) records the Chrysid, *Hedychrum coriaceum*, Dahlb., but evidence adduced by Hamm (1926, p. 319) shows that this ruby-wasp is probably an exclusive parasite of *Lindenius albilabris*, F.

Prey :—

Linné (1761, p. 418), *Musca domestica*, L.

Siebold (1841, p. 9), *Chortophila cilicrura*, Rdi. [*Anthomyia platura*, Mg.], *Dolichopus unguatus*, L., *Ephydra riparia*, Fall., *Fannia mutica*, Zett. [*Anthomyia lepida*, Mg.], *Hydrotæa* [*Anthomyia*] *ciliata*, F., *H. [A.] dentipes*, F., *Lonchæa chorea*, F., *Ophyra* [*Anthomyia*] *leucostoma*, Wied., all males. Further, in one nest, *Coenosia albicornis*, Mg., *Fannia mutica*, Zett. [*Anthomyia lepida*, Mg.] and *Muscina* [*Musca*] *stabulans*, Fall., males, and *Egle radicum* [*Musca ruficeps*, Mg.] and *Scatophaga stercoraria*, L., females. In another nest were, *Anthomyia pluvialis*, L., *Chortophila cilicrura*, Rdi. [*Anthomyia platura*, Mg.], females, and *Onesia* [*Musca*] "*agilis*, Mg.," male (all near Dantzig).

* Chevalier (*Phora pygmaea*, Zett., Diptère mangeur de mouches, 1925, Bull. Soc. Seine-et-Oise, (2) 6: 93-96) has given further particulars of the habits of this fly, which Schmitz (*Megaselia oxybelorum*, n.sp., 1928, Natuurhist. Maanbl., 17: 131-132, 6 figs.) has described as a new species, distinct from *Megaselia (Aphiochaeta) pygmaea*, Zett.

- Dahlbom (1843, p. 273), *Chortophila* [*Aricia*] *longula*, Fall., and *Mydaea* [*Aricia*] *duplaris*, Zett., males (at Lund).
 Fabre (1856b, p. 139), *Anthomyia pluvialis*, L.
 Girard (1879, p. 939), *Haematopota pluvialis*, L.
 Kohl (1880, p. 221), *Fannia* [*Homalomyia*] *incisurata*, Zett., and *F.* [*H.*] *scalaris*, F., males (at Mühldau).
 Sickmann (1891, p. 91), *Chortophila* [*Anthomyia*] *cardui*, Mg., *C. varicolor*, Mg., *Fannia* [*Homalomyia*] *polychaeta*, Stein [*lepidus*, Wied.], males (at Iburg).
 Borries (1897, p. 79), *Hydrotaca irritans*, Fall., *H. velutina*, R.D., *Spilogaster duplicata*, Mg. (in Denmark).
 Morley (1899, p. 7), *Fannia* [*Homalomyia*] *scalaris*, F. (at Ipswich).
 Kiefler (1902, p. 81), especially *Fannia* [*Homalomyia*] *canicularis*, L., also *Lucilia* sp., and *Musca domestica*, L. (at Bitsch).
 Ferton (1910, p. 159), *Anthomyia pluvialis*, L., and *Hylemyia pullula*, Zett. (at Escaffere).
 Séguy (1923, p. 259), *Fannia armata*, Mg., *F. incisurata*, Zett., *F. scalaris*, F., *Ophyra leucostoma*, Wied.
 Grönblom (1925, p. 9), *Fannia* [*Homalomyia*] *manicata*, Mg., and *Lonchaea* (?) *fugax*, Beck. (Finland).
 Chevalier (1926), nearly all *Fannia*, especially *F. scalaris*, F., also *F. canicularis*, L., *Chloria demandata*, F., *Chortophila cinerea*, R.D., *Metopia leucocephala*, Rossi, *Musca domestica*, L., *Phaonia querceti*, Bouché, *Pollenia rudis*, F.

In the present paper 51 specimens of prey are recorded, 42 ♂ and 9 ♀, largely Muscids.

22. *Oxybelus argentatus*, Curt. (*mucronatus*, Brit. Cat.).

Morice (1917, p. 238) has shown that the species occurring in England and formerly known as *O. mucronatus*, F., is not the same as the species known by this name on the continent. The British form, which also occurs in the Channel Islands and on the west coast of France, differs from the other in its silvery pubescence, especially noticeable on the abdomen. It is noteworthy that Smith (1858, p. 163) sent specimens of the British form to be compared with the type, and that they were returned as identical. Fabricius (1793, p. 300) described *mucronatus* from Germany, and, as his diagnosis makes no mention of the silvery hairs, the continental form is probably his species, but the type requires re-examination.

The species is an inhabitant of the sandhills of the west coast of England, and at Porthcawl, for instance, Mr. Hallett tells us it is commoner than *O. uniglumis*, L. Its only prey appears to be the equally silvery fly, *Thereva annulata*, F. (Mortimer, 1905, p. 261; Hallett,* 1916, p. 221; 1921, p. 210).

Nothing appears to be recorded of the habits of *O. sericatus*, Gerst. (*mandibularis*, Auct. nec Dahlb.). According to Morice (*loc. cit.*), our fourth British species, recorded by Saunders (1896) as *O. nigripes*, Ol., is unlike any continental species, but it is only known from a single specimen taken many years ago in Devon.

* Hallett's observation (1916) was unfortunately referred by us (1926, p. 315) to *Crosso-cerus wesmaeli*, V. de Lind., an error reproduced by Berland (1928, p. 180).

TRYPOXYLIDAE.

23. *Trypoxylon figulus*, L.

This is the commonest species of the genus and its habits have been observed in all parts of Europe by numerous hymenopterists. Linné (1767, p. 942) gives the well-known account based on Bergmann's observations at Uppsala. "Habitat . . . in parietum ligneorum foraminibus, ab aliorum insectorum factis relictisque, quae primo purgat circumroditque, deinde fundum argilla obducit, cui araneam imponit, eique ovulum concredit, quo facto nidum argilla claudit. Larva apoda pallida, larvisque apum similis, consumta aranea membranam luteo-fuscam et tenere pupae aptissimam net. Una mater per plurimos nidos construit et plerumque non ultra biduum in quovis adornando consumit."

Excellent accounts have been given more recently by Borries (1897, p. 70), Adlerz (1906, p. 25), Popovici-Bazosanu (1911) and Haverhorst (1916). The nesting-site appears to be always in some already existing burrow, either of a beetle larva in old wood, or in hollowed stems of bramble, reed (Popovici; Müller, 1911), elder, or *Anthriscus sylvestris* (Borries). Smith's record (1848, p. 57) of a large colony in a sandbank is certainly an error. The bottom of the burrow is always lined with mud and a varying number of cells are then built, the barriers between them being also made of mud or clay. Kennedy (1841, p. 15) states that the cells are limited by double barriers. Pigeot (1902) has described such barriers in *T. attenuatum*, Sm., and *T. scutatum*, Chev., but no author since Kennedy has noted them in *T. figulus*, L. The barriers, which are concave on the inner side and convex outwards, are of very variable thickness—1.5–4.0 mm. according to Haverhorst. The mud or clay of which they are made is often derived from different sources, even in the same nest (Borries). The external barrier of the last cell is often thicker than those of the other cells, and there is, further, usually a second barrier at the actual entrance of the burrow, so that there appears to be an empty cell next the entrance. The size of the cells themselves also varies to a considerable extent. The width, of course, depends on the burrow originally chosen, the average being 5 mm. The length varies from 1.2–5.0 cm. (Popovici) or 1.2–1.5 cm. (Pigeot). Sometimes, more especially in the narrower burrows, an empty space is left at the bottom below the first cell. The number of spiders stored appears on the average to be about ten, but various numbers from two to twenty-two have been recorded. According to Adlerz (1906, p. 26) male spiders are stored in the bottom of each cell, the egg being laid on one of the early ones, while female prey are only brought in in the later stages of provisioning. The prey consists largely of the genus *Epeira*, but according to Haverhorst any short-legged, plump, small spider will serve, and actually a large range of genera has been recorded and often from a single nest. The cells are not usually very numerous, burrows of a medium bore having the greatest number—four to nine (Popovici), but often only one or two (Borries). As might be expected from the different amounts of food provided, the size of the wasp varies considerably. Haverhorst notes that even the smallest specimens are quite viable (the mortality being, in fact, extraordinarily low) and are well able to gnaw their way out. He has also made a careful study of the variation of habits in this species, examining in all about 60 nests and 300 cells. In only one of the cells was the egg somewhat doubtfully absent, and in one case the prey had been stored in the normally empty space preceding the exit-hole. He found that the variations in size of cell, thickness of barrier, length of terminal and apical empty chambers, etc., were partly correlated with the diameter of the burrow chosen by the wasp.

Nests with a diameter of 5 mm. were often fairly regular, while narrower or broader ones often showed large variations. Normally there is only one generation in the year, but in artificial conditions a second may be produced in August, and this later generation often builds very irregular nests. He also made the interesting observation that if the barrier between two cells be removed the smaller of the two larvae thus brought into communication, always devours the larger one and then spins up without eating the spiders.

The larval life is quite short, extending over a few days only. The cocoon resembles that of a Eumenid (Verhoeff, 1891, p. 38), being made of thin, whitish-yellow, more or less opaque silk and lying free in the cell. Its length, depending on the sex of the occupant, is from 7-9 or from 10-13 mm. (Popovici). Haverhorst has discussed the meaning of the double external barrier with the empty intervening space. This cannot be much of a protection against parasites, and *Trypoxylon* does not prevent insects from sheltering in the empty cell, merely walling them in. Hence young earwigs have been found hibernating in this space, alive, although without food. Haverhorst noticed, however, that the outer barrier is often destroyed by rain in winter, so that possibly the thick internal barrier with the empty intervening space may be a protection against moisture.

Höppner (1908, pp. 177, 368; 1910, pp. 93, 133, 161) describes bramble-stems containing mixed nests of species of *Trypoxylon*, *Prosopis* and *Odynerus* species. Short biological notes are also given by Westwood (1836, p. 206; 1840, p. 194), Dufour and Perris (1840, p. 28), Giraud (1866, p. 474), Sickmann (1883, p. 63; 1891, p. 81), Nielsen (1900, p. 268), and Kleine (1910, p. 24). Fahringer (1922a, p. 184) records a nest in an old gall of *Cynips kollari*, which was stored with aphides. There has doubtless been some confusion here with a Pemphredonid.

Parasites.—*Megatoma undata*, L. This Dermestid does great damage according to Popovici (1911).

Three species of the Chalcidoid genus *Eurytoma* have been bred from *T. figulus*, L. These are *E. verticillata*, Nees (Goureaux, 1858, p. xli), *E. nodularis*, Boh. (Höppner, 1910, p. 134), and *E. rubicola*, Gir. (Giraud, 1866, p. 474) and Höppner (1904, p. 168). The last two species seem to be synonymous, while Goureaux's identification of the first appears doubtful. Nielsen (1900, p. 268) records another Chalcidoid, viz. *Melittobia acasta*, Walk.

Giraud (1866, p. 474) bred an Evaniid which he identified as *Gasteruption* [*Foenus*] *affectator*, L., and Höppner (1904, p. 101) records the same parasite.

Dufour and Perris (1840, p. 28) bred four Ichneumonids. The synonymy of these has been interpreted by Giraud (1866, p. 474) and Enslin (1922, p. 1). These parasites are:—*Cecidonomus mediterraneus*, Tschek. [*Ichneumon gyrator*, D. & P.], *Ichneumon odiferator*, D. & P., an unidentifiable Cryptine, *Perithous divinator*, Rossi [*Pimpla ephippiatoria*, D. & P.], and *Perithous mediator*, Grav. [*Pimpla marginellatoria*, D. & P.]. Crawshay (1907, p. 207), further, records *Stenodontus marginellus*, Grav.

A considerable number of Chrysidids have been bred at one time or another, but the only really constant parasite of this group appears to be *Chrysis cyanea*, L., which is recorded by Dufour and Perris (*loc. cit.*), Giraud (*loc. cit.*), Morice (1906, p. 216), Alfken (1915a, p. 284; 1915b, p. 294), and Trautmann (1927, p. 136). Haverhorst (1916b, p. 369) also gives a more detailed account of the relations between the parasite and its host. The following Chrysidids have also been recorded:—*C. ignita*, L. (Trautmann, 1927, p. 147), *C. ignita* var. *obtusidens*, D. & P. (Dufour and Perris, *loc. cit.*), *C. splendidula*, Rossi, *C.*

fulgida, L., and *C. fasciata*, Nyl. (Trautmann, 1927), *Omalus auratus*, L. [*Hedychrum minimum*, D. & P.] (Dufour and Perris, *loc. cit.*). *O. pusillus*, F. (Housiaux, 1922).

Amongst the flies Nielsen (1900, p. 268) has recorded *Eustalomyia* [*Hylemyia*] *hilaris*, Fall., while Martineau (1903) states that he found the puparium of *Miltogramma punctatum*, Mg., inside the cocoon of *Trypoxylon*; the fly was successfully bred. This is a remarkable record, for *M. punctatum* is normally a parasite of *Colletes*. Richards (1929) records the Tachinid, *Pachyophthalmus signatus*, Mg.

Prey.—The range, as already noted, is wide, though there is a preference for Epeirids. Haverhorst (1916a, p. 450) found that long-legged spiders such as *Tetragnatha extensa*, L., which were very abundant at the nesting-site, were never captured. Probably the shape and size of the prey are more important than its systematic affinities. The following have been recorded:—Westwood (1836, p. 206; 1840, p. 194)—The young of an *Epeira* probably *diademata*, Cl. (S. England).

Adlerz (1906, p. 28), one cell, ten males and four females of *Linyphia pinnata*, Ström. (Sweden).

Haverhorst (1916, p. 450), *Epeira diademata*, Cl., forms one quarter of the prey in Holland.

Berland (1925, p. 150), a nest of either the present species or *T. attenuatum*, Smith, found by Chevalier near Paris, contained *Araneus* [*Epeira*] sp. very young, *Dictynna arundinacea*, L., *Microneta rupestris*, Koch, *Salticus scenicus*, Cl., *Synageles venator*, Luc., *Xysticus* sp. very young, *Zilla* sp. young; all these spiders were very small.

Berland (1928, p. 179), *Theridion simile*, Koch, *Mangora acalypha*, Walck., *Linyphia triangularis*, Cl., and *L. marginata*, Koch (usually young).

24. *Trypoxylon clavicerum*, Lep.

This is not quite so common a species as *T. figulus*, L., but has an equally wide range of nesting-sites, such as burrows in rotten wood, *e.g.* those made by *Xestobium rufovillosum*, De G. [*Anobium tessellatum*, L.] (Wissmann, 1849, p. 14), straws of thatch (Sickmann, 1891, p. 81), or the stems of *Artemisia vulgaris* bored by the larvae of the moth *Grapholitha foenella*, L. (Borries, 1897, p. 73), and, perhaps most frequently, stems of bramble. The partitions are single and made of mud, the cells being 2.5–3.5 mm. broad, 9–24 mm. long, and one to six in number (Borries). There is usually an extra barrier at the exit hole. The spiders are carried in the mouth of the wasp (Wissmann), six to twelve (Borries) or an average of eight (Sickmann) being stored in each cell. According to Wissmann the legs are bitten off and aphides may be intermingled with the spiders, but these observations have not been confirmed. Kennedy (1838, p. 15) notes that the prey are uniformly small, larger individuals not being captured in addition as in the case of *T. figulus*, L. According to Borries the most common prey consists of long-legged spiders, of which the males are always stored first in each cell, females being selected to complete the provision. The egg is laid on the last prey but one, rarely on the last, and therefore in either case on a female. In a garden at Hampstead, 2 July, 1924, a female of *T. clavicerum* was seen (O.W.R.) hovering in front of the web of a young *Epeira diadema*, L. The spider moved so as always to face the wasp, which was evidently recognised as an enemy.

At Shotover, Oxford, this wasp was observed (A.H.H.) at the same time and place as *Pemphredon lugubris*, Latr. The *Trypoxylon* was nesting in holes made, apparently, by some wood-boring beetle. If the holes were too large they were reduced to the requisite size by a lining of mud-like cement. The males were continually going in and out of the burrows with, as far as could be seen, no particular object. Each of their visits was of only a few moments' duration. The prey consisted chiefly of very small Epeirid spiders; two of them were examined and one proved to be dead, the other paralysed, but with some power of movement in the legs. The spiders were carried either by the mouth or by means of the wasp's anterior legs, but it was not possible to decide which of these two methods was actually adopted, for the spider was dropped as soon as the wasp was boxed.

Parasites.—*Ephialtes manifestator*, L. (Wissmann). *Omalus pusillus*, F., Housiaux (1922). Schumann (1899) records the beetle, *Pelecotoma fennica*, Ph., as a possible parasite.

Prey.—Sickmann (1891, p. 81), from one nest at Iburg;—*Epeira agelena*, Walck., two; *E. cucurbitina*, Cl., twenty-five; *E. patagiata*, Cl., one; *Linyphia hortensis*, Sund., three; *Lycosa* sp., one; *Pachygnatha* sp., one; *Tetragnatha extensa*, L., six; *Theridion varians*, Hahn, one; species too young to identify, sixteen.

In the present paper 45 specimens of prey are recorded, and except for two females, all are sexually immature, and many so young as to be quite unidentifiable. Epeirids appear to predominate. From this list it would appear that *T. clavicerum* attacks more particularly spiders in their first, or at least one of the very early, moult-stages.

25. *Trypoxylon attenuatum*, Smith.

This species appears to nest exclusively in hollow plant-stems, perhaps never in rotten wood like the other species of the genus. The stems of bramble are frequently chosen (Saunders, 1896, p. 86), but raspberry stems (Borries, 1897, p. 75), straws of thatch (Sickmann, 1891, p. 81), reeds (Müller, 1911, p. 107) and dock-stems (Pigeot, 1902) are also used. Borries found that the cells were separated by pith-barriers, with no trace of mud, the intervals and the lengths of the cells being more regular than in the other species. Pigeot, however, states that a double mud barrier is constructed between consecutive cells. The length of the cells averages 8–9 mm. The mud is less agglutinated and of a coarser texture than it is in the nests of *T. figulus*, L.

Parasites.—*Chrysis cyanea*, L. (Trautmann, 1927, p. 39). *Omalus auratus*, L., and *O. pusillus*, F. (Housiaux, 1922). *Eurytoma rubicola*, Gir. (Höppner, 1904, p. 168).

Pachyophthalmus signatus, Mg. (Chevalier, 1924b). This Tachinid fly was found to be a common parasite near Paris. The flies settled near the mouth of the nest, waiting for the owner to come out. As soon as the wasp leaves the fly enters and in two seconds extrudes her larva (the species being larviparous), which makes its own way into the cell.

Prey.—For Chevalier's observations, quoted by Berland (1925), which may apply to the present species, see under *T. figulus*, L.

In the present paper 58 specimens of prey are recorded, none of them sexually mature. In an interesting nest found by Dr. R. C. L. Perkins at Bovey Tracey, S. Devon, all the prey (52 specimens) consisted of a single species of spider, *Bolyphantes luteolus*, Bl.

LIST OF PREY.

LOCALITY AND DATE.	SPECIES AND SEX OF PREY.	DETERMINED BY.	NOTES, AND OBSERVER WHEN NOT A.H.H.
England. No data.	Mellinus arvensis, L.		
	<i>Egle radicum</i> , L., ♀.	J.E.C.	G. Arnold.
	<i>Fannia canicularis</i> , L., 1♂, 1♀.	J.E.C.	
	<i>Lonchaea flavidipennis</i> , Zett., ♂.	J.E.C.	
	<i>Musca domestica</i> , L., 2♂.		
Nr. Godalming, Surrey.	<i>Calliphora erythrocephala</i> , Mg., ♂.	O.W.R.	O. H. Latter.
Shotover, Oxford. July to Sept. '97.	<i>Musca corvina</i> , F., 2♂, 1♀.	E.E.A.	
Dartmouth, Devon. Sept. '99.	<i>Sarcophaga vicina</i> , Villen. or <i>S. carnaria</i> , L., ♂.	O.W.R.	R. C. L. Perkins.
Mildenhall, Suffolk. Sept. '99.	<i>Poliates lardaria</i> , F., ♀.	O.W.R.	R. C. L. Perkins.
Golspie, Sutherland. 11 Aug. '00.	<i>Orthellia caesarion</i> , Mg., ♀.	O.W.R.	J. W. Yerbury.
Newton Abbot, S. Devon. 8 Aug. '02.	<i>Scatophaga stercoraria</i> , L., ♂.	J.E.C.	
Barmouth, Merioneth. 5 Sept. '02.	<i>Prosenia sybarita</i> , F., ♀.	J.W.Y.	J. W. Yerbury.
Pamber, Hants. 20 Aug. '04.	<i>Deziosoma caninum</i> , F., ♀.	E.E.A.	
	<i>Musca corvina</i> , F., ♂.	E.E.A.	
Hildesheim, Germany. Sept. '07.	<i>Eriothrix rufomaculata</i> , De G., ♀.	O.W.R.	H. Scott.
Padstow, Cornwall. Sept. '09.	<i>Mydaea communis</i> , Desv., ♀.	J.E.C.	C. G. Lamb.
	<i>Orthellia caesarion</i> , Mg., ♀.	O.W.R.	C. G. Lamb.
Tubney, Berks. No date.	<i>Exorista</i> sp., ♀.	J.E.C.	
The same. Aug. '10.	<i>Calliphora erythrocephala</i> , Mg., ♀.	O.W.R.	Fragments.
	<i>Lonchaea</i> sp., ♀.	O.W.R.	
	<i>Pollenia rudis</i> , F., 2 ♀.	O.W.R.	
The same. 1 Aug. '10.	<i>Hydrophoria conica</i> , Wied., ♀.	J.E.C.	
The same. 25 Aug. '10.	<i>Calliphora erythrocephala</i> , Mg., 4♂, 2♀.	O.W.R.	
	<i>Melinda caerulea</i> , Mg., ♀.	O.W.R.	
	<i>Mydaea lucorum</i> , Fall., ♀.	J.E.C.	
	<i>Pales pavida</i> , Mg., ♂.	J.E.C.	
	<i>Phaonia signata</i> , Mg., ♀.	J.E.C.	
	<i>Plesina maculata</i> , Fall., ♀.	J.E.C.	
	<i>Poliates lardaria</i> , F., 1♂, 2♀.	O.W.R.	
	<i>Pollenia rudis</i> , F., 6♂, 8♀.	O.W.R.	
The same. 28 Aug. '10.	<i>Calliphora erythrocephala</i> , Mg., 6♂, 4♀.	O.W.R.	
	<i>Poliates lardaria</i> , F., ♂.	O.W.R.	
	<i>Pollenia rudis</i> , F., 7♂, 2♀.	O.W.R.	
	<i>Syrphus corollae</i> , F., ♂.	O.W.R.	
	<i>Thereva nobilitata</i> , F., ♀.	O.W.R.	
The same. 1 Sept. '10.	<i>Calliphora erythrocephala</i> , Mg., 2♂, 5♀.	O.W.R.	
	<i>Dasyphora cyanea</i> , Mg., ♂.	O.W.R.	
	<i>Melinda caerulea</i> , Mg., 1♂, 1♀.	O.W.R.	
	<i>Poliates lardaria</i> , F., 1♂, 1♀.	O.W.R.	
	<i>Pollenia rudis</i> , F., 18♂, 18♀.	O.W.R.	
The same. 9 Nov. '22.	<i>Calliphora erythrocephala</i> , Mg., 2♂.	O.W.R.	O.W.R.; taken from burrows.
	<i>Phaonia signata</i> , Mg., ♂.	J.E.C.	
	<i>Poliates lardaria</i> , F., ♂.	O.W.R.	
	<i>Pollenia rudis</i> , F., ♂.	O.W.R.	
The same. 8 Aug. '26.	<i>Sarcophaga</i> sp., ♀.	O.W.R.	O.W.R.
Shotover, Oxford. 11 Sept. '10.	<i>Calliphora erythrocephala</i> , Mg., 6♂, 4♀.	O.W.R.	
	<i>Coenosia tigrina</i> , F., 2♀.	O.W.R.	
	<i>Onesia</i> sp., ♀.	O.W.R.	
	<i>Orthellia cornicina</i> , F., 1♂, 1♀.	O.W.R.	
	<i>Poliates abolineata</i> , Fall., ♂.	O.W.R.	
	<i>Poliates lardaria</i> , F., ♀.	O.W.R.	
	<i>Pollenia rudis</i> , F., 11♂, 12♀.	O.W.R.	
	<i>Scatophaga stercoraria</i> , L., ♂.	O.W.R.	
The same. 25 Sept. '10.	<i>Hylemyia strigosa</i> , F., ♀.	J.E.C.	
	<i>Poliates lardaria</i> , F., ♀.	O.W.R.	
	<i>Pollenia rudis</i> , F., 4♂, 4♀.	O.W.R.	
	<i>Scatophaga stercoraria</i> , L., ♀.	O.W.R.	

LOCALITY AND DATE.	SPECIES AND SEX OF PREY.	DETERMINED BY.	NOTES, AND OBSERVER WHEN NOT A.H.H.
Hastings, Sussex. 24 Aug. '11.	<i>Calliphora erythrocephala</i> , Mg., ♂. <i>Ceromastia senilis</i> , Mg., ♂. <i>Lucilia</i> sp. near <i>caesar</i> , L., ♀. <i>Lucilia sericata</i> , Mg., 1 ♂, 1 ♀. <i>Orthellia caesarion</i> , Mg., ♀. <i>Syrphus corollae</i> , F., ♀. <i>S. vitripennis</i> , Mg., ♀. <i>Calliphora erythrocephala</i> , Mg., ♂. <i>Lucilia</i> sp. near <i>sericata</i> , Mg., 4 ♀. <i>Musca domestica</i> , L., ♂. <i>Sarcophaga</i> sp., ♀.	O.W.R. J.E.O. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. } O.W.R. } O.W.R. }	C. H. Hamm. C.H.H.; flies lying near the burrows, probably dropped by the wasps.
Beaulieu Rd., New Forest, Hants. 22 Aug. '12.	<i>S. carnaria</i> , L., ♂.	O.W.R.	
Oxshott, Surrey. 7 Sept. '22.	<i>Pollenia vespillo</i> , F., ♀.	O.W.R.	O.W.R.
The same. 6 Sept. '24.	<i>Musca corvina</i> , F., 1 ♂, 2 ♀. <i>Polietes lardaria</i> , F., 3 ♂. <i>Polietes vespillo</i> , F., ♀.	O.W.R. O.W.R. O.W.R.	
The same. 18 Sept. '24.	<i>Musca corvina</i> , F., ♂.	O.W.R.	O.W.R.
Wavenden, Beds. 5 Sept. '26.	<i>M. corvina</i> , F., ♂.	O.W.R.	O.W.R.
Tresco, Isles of Scilly. 15 July '27.	<i>Fucomyia frigida</i> , Fall., ♀.	O.W.R.	W. S. Bristowe.
Shapwick, Somerset. 15 Sept. '27.	<i>Onesia</i> sp., ♀. <i>Pollenia vagabunda</i> , Mg., ♀.	O.W.R. O.W.R.	J. Balfour-Browne.
Mellinus arvensis , L. var. alpinus , Handl.			
Schlern, Seiser Alpe, Tyrol. 2 Aug. '94.	<i>Paramacronychia flavipalpis</i> , Girschn., ♀.	J.E.O.	Captured by H. Friese; pres. by Rev. F. D. Morice.
Seiser Alpe, Tyrol. 30 Aug. '25.	<i>Pollenia atramentaria</i> , Mg., ♂. <i>P. rudis</i> , F., ♀.	O.W.R. O.W.R.	O.W.R.
Harpactus tumidus , Pz.			
Bovey Tracey, S. Devon. 13 Aug. '00.	<i>Acocephalus nervosus</i> , Schrk., ♀.	E.S.	
Philanthus triangulum , F.			
Mende, Lozère, France. 11 Aug. '27.	<i>Apis mellifera</i> , L.	O.W.R.	O.W.R.
Cerceris arenaria , L.			
Oddcombe, S. Devon. 16 July '98.	<i>Otiorrhynchus tenebriosus</i> , Hbst., ♂.	J.J.W.	
Mildenhall, Suffolk. July '99.	<i>Otiorrhynchus singularis</i> , L. (<i>picipes</i> , F.), ♀.	O.W.R.	R. C. L. Perkins; specimen in the Cambridge Museum.
Bovey Tracey, S. Devon. 11 Aug. '02.	<i>Otiorrhynchus sulcatus</i> , F., 1.	J.J.W.	
Lyme Regis, Dorset. 30 July '05.	<i>O. scabrosus</i> , Marsh., 2. <i>O. sulcatus</i> , F., 18.	A. J. Chitty.	A. J. Chitty; the wasp was carrying in one <i>O. sulcatus</i> , while the other beetles were dug up.
Denny Bog, New Forest, Hants. 8 Aug. '09.	<i>Balaninus venosus</i> , Grav., ♂. <i>Otiorrhynchus singularis</i> , L. (<i>picipes</i> , F.), 16 ♀. <i>Strophosomus capitatus</i> , De G., 1. <i>S. faber</i> , Hbst., 1 ♂, 2 ♀. <i>S. lateralis</i> , Ph., 5. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 9.	J.J.W. O.W.R. J.J.W. J.J.W. J.J.W. J.J.W.	
The same. 13 Aug. '09.	<i>Otiorrhynchus singularis</i> , L. (<i>picipes</i> , F.), ♀. <i>Strophosomus melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 1.	J.J.W. J.J.W.	
The same. 14 Aug. '09.	<i>Otiorrhynchus singularis</i> , L. (<i>picipes</i> , F.), 12 ♀. <i>Strophosomus faber</i> , Hbst., 1 ♂, 2 ♀. <i>S. lateralis</i> , Pk., 4. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 1.	J.J.W. J.J.W. J.J.W. J.J.W.	
Matley Bog, New Forest, Hants. 13 Aug. '09.	<i>Balaninus venosus</i> , Grav., 1 ♂, 1 ♀.	J.J.W.	
Poole Harbour, Dorset. 15 Aug. '09.	<i>Otiorrhynchus singularis</i> , L. (<i>picipes</i> , F.), 1 ♀. <i>O. sulcatus</i> , F., 1.	J.J.W. J.J.W.	

LOCALITY AND DATE.	SPECIES AND SEX OF PREY.	DETERMINED BY.	NOTES, AND OBSERVER WHEN NOT A.H.H.
Beaulieu Rd. Station, New Forest, Hants. 18 Aug. '09.	<i>Otierrhynchus singularis</i> , L. (<i>picipes</i> , F.), 6 ♀. <i>Strophosomus lateralis</i> , Pk., 2. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 1. <i>S. retusus</i> , Marsh., ♂.	J.J.W. J.J.W. J.J.W. J.J.W.	
Esher Common, Surrey. Aug. '20.	<i>Otierrhynchus singularis</i> , L. (<i>picipes</i> , F.), ♀. <i>Strophosomus faber</i> , Hbst., ♂. <i>S. lateralis</i> , Pk., 1.	O.W.R. O.W.R. O.W.R.	Prey of one wasp.
The same. 7 Aug. '20.	<i>Otierrhynchus singularis</i> , L. (<i>picipes</i> , F.), 2 ♀. <i>O. sulcatus</i> , F., 1. <i>Strophosomus faber</i> , Hbst., 2 ♂. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 1. <i>Otierrhynchus scabrosus</i> , Marsh., 1. <i>O. singularis</i> , L. (<i>picipes</i> , F.), 9 ♀. <i>O. sulcatus</i> , F., 1. <i>Strophosomus faber</i> , Hbst., 2 ♂. <i>S. lateralis</i> , Pk., 1. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 2.	O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R.	Prey of one wasp. Of these, a single wasp carried 3 and another 2.
The same. 12 Aug. '20.	<i>Otierrhynchus singularis</i> , L. (<i>picipes</i> , F.), 1 ♀.	O.W.R.	
The same. 13 Aug. '20.	<i>Hylotius abietis</i> , L., 2. <i>Otierrhynchus singularis</i> , L. (<i>picipes</i> , F.), 3 ♀. <i>Sitona lineata</i> , L., 1. <i>Strophosomus faber</i> , Hbst., 2 ♂, 1 ♀. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 3 (2 immature).	O.W.R. O.W.R. O.W.R. O.W.R. O.W.R.	One wasp was carrying a male and female of this.
The same. 14 Aug. '20.	<i>Otierrhynchus sulcatus</i> , F., 1.	O.W.R.	
The same. 11 Aug. '22.	<i>Pissodes notatus</i> , F., 1. <i>Strophosomus faber</i> , Hbst., ♂. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 5.	O.W.R. O.W.R. O.W.R.	
The same. 15 Aug. '22.	<i>Balaninus venosus</i> , Grav., ♂. <i>Otierrhynchus singularis</i> , L. (<i>picipes</i> , F.), ♀. <i>Pissodes notatus</i> , F., 1. <i>Strophosomus melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 2.	O.W.R. O.W.R. O.W.R. O.W.R.	
The same. 18 Aug. '22.	<i>Otierrhynchus sulcatus</i> , F., 1. <i>Strophosomus lateralis</i> , Pk., 1. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 2.	O.W.R. O.W.R. O.W.R.	
The same. 19 Aug. '22.	<i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 1.	O.W.R.	
The same. Sept. '22.	<i>Otierrhynchus singularis</i> , L. (<i>picipes</i> , F.), 7 ♀.	O.W.R.	All from one burrow.
The same. 1 July '25.	<i>Strophosomus capitatus</i> , De G., 1. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 4.	O.W.R. O.W.R.	O.W.R.
The same. 6 July '25.	<i>Balaninus venosus</i> , Grav., 1 ♂, 1 ♀. <i>Strophosomus capitatus</i> , De G., 1. <i>S. faber</i> , Hbst., ♂. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 2.	O.W.R. O.W.R. O.W.R. O.W.R.	O.W.R.
The same. 26 Dec. '25.	<i>Balaninus venosus</i> , Grav., at least 3. <i>B. venosus</i> , Grav., at least 10. <i>B. venosus</i> , Grav., at least 6. <i>Pissodes notatus</i> , F., 2. <i>Strophosomus melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 13. <i>Pissodes notatus</i> , F., 1. <i>Strophosomus capitatus</i> , De G., 1. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 25. <i>S. sp.</i> , 1. <i>Balaninus venosus</i> , Gr., 8. <i>Otierrhynchus singularis</i> , L. (<i>picipes</i> , F.), 3 ♀.	O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R.	One cell. One cell. One cell. One cell. One cell. One cell. One cell. One cell. A random assortment from various burrows. O.W.R.

LOCALITY AND DATE.	SPECIES AND SEX OF PREY.	DETERMINED BY.	NOTES, AND OBSERVER WHEN NOT A.H.H.
Continued.	<i>Pissodes notatus</i> , F., 1. <i>Strophosomus capitatus</i> , De G., 15. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 88. <i>S. sp.</i> , 6. Weevil fragment, 1.	O.W.R. O.W.R. O.W.R. O.W.R. O.W.R.	
The same. 6 Aug. '28.	<i>Otiorrhynchus singularis</i> , L. (<i>picipes</i> , F.), 2 ♀. <i>Strophosomus lateralis</i> , Pk., 5. <i>S. melanogrammus</i> , Foerst. (<i>coryli</i> , F.), 5.	J.J.W. J.J.W. J.J.W.	
Porth Lake, Cornwall. 17 to 19 Aug. '27.	<i>Otiorrhynchus sulcatus</i> , F., 3.	O.W.R.	Dr. J. W. Munro.
<i>Cerceris labiata</i>, F.			
Fleet, Hants. 18 Aug. '99.	<i>Strophosomus lateralis</i> , Pk., 2.	O.W.R.	A sample of a number in one nest.
<i>Cerceris quinquefasciata</i>, Rossi.			
Tubney, Berks. 4 Aug. '08.	<i>Meligethes aeneus</i> , F., ♀. <i>M. viridescens</i> , F., 2 ♀.	J.J.W. J.J.W.	
<i>Cerceris rybyensis</i>, L.			
Henley, Berks. 25 Aug. '07.	<i>Halictus rubicundus</i> , Chr., ♀.	R.C.L.P.	H. Scott. Specimen in the Cambridge Museum.
Tubney, Berks. 4 Aug. '08.	<i>Andrena gwynana</i> , K., 3 ♀. <i>Halictus albipes</i> , K., ♂. <i>H. calceatus</i> , Scop., ♂. <i>H. leucozonius</i> , K., 4 ♂.	E.S. E.S. E.S. E.S.	
The same. 4 Aug. '09.	<i>Andrena marginata</i> , F. (<i>ceti</i> , Schrk.), E.S. ♀. <i>Halictus calceatus</i> , Scop., 2 ♀. <i>H. rubicundus</i> , Chr., ♀.	E.S. E.S.	
The same. 1 Aug. '10.	<i>Andrena gwynana</i> , K., ♂. <i>Halictus calceatus</i> , Scop., 2 ♀. <i>H. rubicundus</i> , Chr., ♀. <i>H. tumulorum</i> , L., ♀.	O.W.R. O.W.R. O.W.R. O.W.R.	
The same. 1 Sept. '10.	<i>H. calceatus</i> , Scop., ♀. <i>H. leucozonius</i> , K., ♀.	O.W.R. O.W.R.	
The same. 14 July '12.	<i>Andrena coitana</i> , K., ♀. <i>A. gwynana</i> , K., 2 ♂, 1 ♀. <i>Halictus albipes</i> , K., ♀. <i>H. calceatus</i> , Scop., 3 ♂, 1 ♀. <i>H. leucozonius</i> , K., 2 ♀. <i>H. smeathmanellus</i> , K., ♀.	O.W.R. O.W.R. O.W.R. O.W.R. O.W.R. O.W.R.	
The same. 5 Aug. '13.	<i>Andrena minutula</i> , K., ♀. <i>Halictus leucozonius</i> , K., ♂. <i>H. calceatus</i> , Scop., 2 ♀. <i>H. smeathmanellus</i> , K., 3 ♀. <i>H. villosulus</i> , K., ♂.	O.W.R. } O.W.R. } O.W.R. O.W.R. O.W.R.	Prey of one wasp.
Nr. Godalming, Surrey.	<i>Andrena</i> , ? <i>wilkella</i> , K., ♀. <i>Halictus morio</i> , K., ♂. <i>H. quadrinotatus</i> , K., ♂.	O.W.R. O.W.R. O.W.R.	O. H. Latter.
<i>Oxybelus uniglumis</i>, L.			
Shotover, Oxford. June '87.	<i>Mydaea communis</i> , Desv., ♂.	J.E.C.	R. C. L. Perkins. Specimens in the Cambridge Museum.
Deal, Kent. 12 July '96.	<i>Scatophaga stercoraria</i> , L., ♂.	J.E.C.	F. W. L. Sladen.
Mildenhall, Suffolk. July '99.	<i>Nyctia halterata</i> , Pz., ♀.	O.W.R.	R. C. L. Perkins. Specimens in the Cambridge Museum.
Sandown, Isle of Wight. 7 Aug. '99.	<i>Mydaea communis</i> , Desv., ♂.	J.E.C.	
New Forest, Hants. 26 May to 4 July '01.	<i>Hydrotaea irritans</i> , Fall., 1 ♂, 1 ♀.	O.W.R.	D. Sharp. Specimens in the Cambridge Museum.
Wroxham, Norfolk. 5 Sept. '02.	<i>Egle aestiva</i> , Mg., 2 ♂. <i>Mydaea duplicata</i> , Mg., ♂.	J.E.C. J.E.C.	G. A. K. Marshall.
Porthcawl, Glamorgan. 28 June '03.	<i>Helina duplicata</i> , Mg., ♂.		J. W. Yerbury.
Tubney, Berks. 2 July '05.	<i>Chirosia albitarsis</i> , Zett., ♂. <i>Coenostia tigrina</i> , F., ♀. <i>Hydrotaea irritans</i> , Fall., ♂.	J.E.C. G.H.V. P. Grimshaw.	J. Collins.
The same. 1 July '06.	<i>H. irritans</i> , Fall., ♂.	J.W.Y.	
Chobham, Surrey. 7 July '06.	<i>Lasiomma ctenoctema</i> , Kow., ♂.	J.E.C.	F. D. Morice.

LOCALITY AND DATE.	SPECIES AND SEX OF PREY.	DETERMINED BY.	NOTES, AND OBSERVER WHEN NOT A.H.H.
Shotover, Oxford. 21 July '07.	<i>Phorbia brassicae</i> , Bouché, ♂.	J.E.C.	
Beaulieu Rd., New Forest, Hants. 8 Aug. '09.	<i>Mydaea duplicata</i> , Mg., ♂.	J.E.C.	
Tubney, Berks. 28 June '09.	<i>Egle cinerella</i> , Fall., ♂.	J.E.C.	
	<i>Pollenia rudis</i> , F., 2 ♂.	O.W.R.	
	<i>Sphecapata conica</i> , Fall., ♂.	J.E.C.	
The same. 5 Aug. '13.	<i>Phorbia brassicae</i> , Bouché, ♂.	J.E.C.	
Matley Bog, New Forest, Hants. 11 Aug. '14.	<i>Musca corvina</i> , F., ♂.	O.W.R.	
Shotover, Oxford. 27 July '16.	<i>Crinura trichodactyla</i> , Rdl., ♂.	J.E.C.	
Oxshott, Surrey. 13 Aug. '20.	<i>Musca corvina</i> , F., ♀.	O.W.R.	
Esher Common, Surrey. 15 Aug. '22.	<i>Musca corvina</i> , F., ♀.	O.W.R.	Dropped by wasp outside burrow. Prey of one wasp.
	<i>M. corvina</i> , F., ♀.	O.W.R. }	
	<i>Sarcophaga striata</i> , F., ♂.	O.W.R. }	
The same. 18 July '23.	<i>Sarcophaga striata</i> , F., ♂.	O.W.R.	O.W.R.
Tubney, Berks. 20 July '23.	<i>Egle aestiva</i> , Mg., ♀.	J.E.C.	
Esher Common, Surrey. 1 July '24.	<i>Musca corvina</i> , F., ♀.	O.W.R.	O.W.R.
Esher Common, Surrey. 1 July '25.	<i>Fannia polychaeta</i> , Stein., 2 ♂.	J.E.C.	O.W.R.
The same. 9 July '25.	<i>Mydaea communis</i> , Desv., ♂.	J.E.C.	O.W.R.
Hamptstead Heath, Middx. 30 June '26.	<i>Egle dissecta</i> , Mg., ♂.	J.E.C.	O.W.R.
	<i>Fannia armata</i> , Mg., ♂.	O.W.R.	O.W.R.
The same. 27 Aug. '26.	<i>Platychirus clypeatus</i> , Mg., ♂.	O.W.R.	O.W.R.
Dorchester, Dorset. 19 Aug. '26.	<i>Egle dissecta</i> , Mg., 9 ♂.	J.E.C.	G. M. Spooner. Specimens in the Cambridge Museum.
Esher Common, Surrey. 6 Aug. '28.	<i>Hydrotaea irritans</i> , Fall., ♂.	J.E.C.	
	<i>H. meteorica</i> , L., ♀.	J.E.C.	
	<i>Platychirus albimanus</i> , F., 3 ♂.	J.E.C.	
Oxybelus argentatus , Curt.			
Llangennith, Glamorgan. July '21.	<i>Thereva annulata</i> , F., ♂.	O.W.R.	H. M. Hallett.
Trypoxylon clavicerum , L.			
Y. = too immature to identify. England.	Linyphiid (very young).	W.S.B.	R. C. L. Perkins. Specimens in the Cambridge Museum.
Shotover, Oxford. 22 July '06.	<i>Meta segmentata</i> , Cl., 3.	F.B.S.	
The same. 7 Aug. '06.	<i>Micryphantes rurestris</i> , Koch, 1.	F.B.S.	
The same. 25 Aug. '07. "	Spiders, Y. 7.	A.R.J.	
The same. 4 July '09.	<i>Epeira</i> sp.	A.R.J.	
	Spiders, Y. 2.	A.R.J.	
The same. 7 Aug. '09.	Spider, Y.	A.R.J.	
The same. 10 Aug. '09.	Spider, Y.	A.R.J.	
The same. 12 Aug. '09.	Spiders, Y. 2.	A.R.J.	
The same. 28 Aug. '10.	Spiders, Y. 2.	A.R.J.	
Southfield Rd., Oxford. 12 July '14.	<i>Linyphia</i> sp. Spider, Y.	A.R.J.	
The same. 4 July '15.	<i>Epeira diademata</i> , Cl.	A.R.J.	
Bayswater, Oxford. 16 Aug. '15.	Spiders, Y. 6. Further one wasp with 11 Spiders, Y.	A.R.J.	
Trypoxylon attenuatum , Sm.			
Bovey Tracey, S. Devon. 9 Dec. '12.	<i>Bolyphantes luteolus</i> , Bl., 40.	W.S.B.	R. C. L. Perkins; two fully stored cells contained 19 and 17 Spiders, respectively.
	Spiders, Y. 12. These include a few <i>Bathyphantes</i> sp.	W.S.B.	
Shapwick, Somerset. Sept. '27.	<i>Tetragnatha</i> sp.	W.S.B.	J. Balfour-Browne.
	Linyphiids (2 very young).	W.S.B.	
Porquerolles, Var, France 29 Aug. '27.	<i>Tetragnatha</i> sp.	W.S.B.	O.W.R.; nest in the stem of asphodel.
	Linyphiids (2 very young).	W.S.B.	

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NOTES ON SOUTH AMERICAN LYCAENIDAE, WITH DESCRIPTIONS OF NEW SPECIES

By PERCY I. LATHY, F.Z.S.

[Read December 4th, 1929.]

PLATE IX.

SINCE my paper on "The American Theclinae," *Ann. Mag. Nat. Hist.*, (9) 17: 35, January 1926, Madame Fournier has made several additions to her collection, which bring further facts to light and add to the number of species. The object of this paper is to deal with these, and at the same time I take the opportunity to figure some of the species previously described.

Trichonis immaculata, sp. n.

T. theanus, Hew. Ill. Diurn. Lep., pl. 29, fig. 2 (1865).

♂. Differs from *theanus*, Cram., in having submarginal black border of fore-wing above narrower and more regular; on the hind-wing above the apex is black. The hind-wing below is without the conspicuous black spot at anal angle. Fore-wings are more rounded.

Exp. 36 mm.

1 ♂. *Hab.* (?)

Hewitson took these two species to be opposite sexes, but a glance at his figure shows them both to be males. Draudt in Seitz, Pl. 146, appears to have reproduced Hewitson's figures, that of the upperside being *immaculata* and the underside typical *theanus*.

Thecla ducalis, D. & H. Pl. IX, figs. 3, 4.

T. ducalis, D. & H. Gen. Diurn. Lep., pl. 77, fig. 1 (1852).

There has been considerable confusion in collections respecting this species. It is one of those cases where a species has been figured but there is no accompanying description, and as only the upperside is shown the figure might apply to the female of *imperialis*, Cram. As a matter of fact Druce took the female of *oakesii*, Butl., a local race of *imperialis*, to be *ducalis*. Draudt in Seitz, p. 746, also regards *ducalis* as a race of *imperialis* and places *oakesii* as a synonym. This is incorrect, as a glance at the figures on Pl. IX will show. *T. ducalis* is quite a distinct species and not a race of *imperialis*, as the two occur together in South Brazil.

Madame Fournier has 6 ♂♂ and 3 ♀♀ of *ducalis* from Petropolis.

T. imperialis has a wider range, and the name of *oakesii*, Butl., Pl. IX, figs. 1, 2, may be retained for the Colombian race in which the females have a rosy tint in the cell of the hind-wing below. This is more diffused than in *ducalis*, and the marginal orange border is lacking. It is quite probable that other races are sufficiently distinct to have a name, but at present I have not sufficient material before me to venture to describe them.

The series in Madame Fournier's collection is as follows:—

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- 1 ♂. La Merced, Peru. 2500-3500 ft. x, xi.1919. C. Watkins.
 1 ♂. Rio Tono, Peru. 1200 ft. C. Watkins.
 1 ♀. Taropoto, Peru. Michael.
 2 ♂♂. Santarem, Amazons. A. H. Fassl.
 1 ♂. " " x.1922. H. Boy.
 1 ♂, 1 ♀. Amazons.
 1 ♂, 1 ♀. Rio de Janeiro, Brazil. E. May.
 4 ♂♂. Santa Catharina.
 5 ♂♂, 2 ♀♀. Maroni, French Guiana.
 1 ♂. Dutch Guiana.
 16 ♂♂, 13 ♀♀. Colombia. = *oakesii*, Butl.
 1 ♂. Chanchamayo, Peru.
 5 ♂♂, 2 ♀♀. (?).

***Thecla gloriosa*, sp. n. Pl. IX, fig. 5.**

♂. Upperside similar in colouring to *T. ornatrix*, Druce, but no androconial patch within cell. Underside has the ground-colour more bluish-green than in *ornatrix*, Druce. The fore-wing has postdiscal lines less strongly marked. On the hind-wing the discal black-edged white line is outwardly bordered with wide black band between costa and lower median nervule. This is narrowly edged with greenish-blue and the upper part of this is bordered with black; the lower half of outer margin clouded with black.

Exp. 68 mm.

1 ♂. Colombia. Chocó, Rio Micai-Joly. 23.v-18.vi.1924. Werner Hopp.

This fine species is very much larger than *ornatrix*, Druce, of which the largest specimen I have before me only measures 52 mm.

***Thecla cuprea*, sp. n. Pl. IX, fig. 6.**

♂. This species also is allied to *ornatrix* and *gloriosa*. It differs from the former in having no androconial patch in cell of fore-wing above, and from both in having the veins of both wings narrowly edged with black distally. On the underside the beautiful golden-copper reflection of the ground-colour distinguishes it at once from both the allied species; the inner postdiscal line of fore-wing is inclined and not parallel. The pattern of the hind-wing more resembles that of *gloriosa*, but there is no black clouding on outer margin.

Exp. 52 mm.

1 ♂. Macas, Ecuador. 1905-6.

***Thecla tagyroides*, sp. n. Pl. IX, fig. 7.**

♂. Nearly allied to *tagyra*, Hew., but the androconial patch of fore-wing above does not invade the cell. The discal black bands of hind-wing below are regular, being composed of equal-sized patches.

♀. On the underside of hind-wing differs from *tagyra* in the same manner as the male.

Exp. ♂, 40-56 mm.; ♀, 48 mm.

- 2 ♂♂, 1 ♀. Maroni, French Guiana. Types.
 2 ♂♂. Obidos, Amazons. A. H. Fassl.
 1 ♂. Manaos, Amazons. "
 1 ♂. Manicore, Amazons.
 1 ♂. Rio Manes, Amazons.
 1 ♂. Moja, Amazons. i.1923. H. Boy.

***Thecla mirabilis*, sp. n. Pl. IX, fig. 8.**

♂. The upperside of this species in colouring resembles that of *T. draudti*, Lathy, but the shape is entirely different, the wings being much more rounded. The cell is closed with a tiny patch of androconia and just beyond is a small round patch of androconia.

Below the fore-wing is a beautiful bright shining azure blue, bordered on the costa and outer margin with metallic green; inner margin greyish. The hind-wing is bright metallic green, a subbasal row of four, with following series of black patches, the upper almost square, the next triangular, the third elongated and the last oval; a discal series of four, the upper oval, the second almost round, the third as in the last series and the fourth elongated; two postdiscal patches situated beyond the middle patches of the last series and a submarginal row of spots not extending to apex. Fringes and tails black narrowly edged with white.

Exp. 46 mm.

1 ♂. Rio Pastazza, Eastern Ecuador.

***Thecla commodus viridis*, subsp. n.**

♂. Differs above from the typical form in having the shining blue area replaced by green and greatly reduced, only the basal third of both wings being occupied. The underside resembles the typical form, but is somewhat paler.

Exp. 32 mm.

1 ♂. *Hab.* (?), probably Bolivia.

***Thecla dolyas pallida*, subsp. n.**

♂. Differs from the typical form in having the androconial patch of fore-wing above of almost the same colour as the marginal border and not bordered with black. The hind-wing above has the costa broadly bordered with white and the apex with much less dark grey, thus making a series of distinct marginal spots below it. The underside of both wings paler and the bands enlarged.

Exp. 30 mm.

1 ♂. *Hab.* (?).

***Thecla janthina venezuelae*, subsp. n.**

♂. Differs from *janthina* in being larger, having the blue area of a violet tinge and paler, almost transparent. The undersurface of both wings paler and the markings less defined; the hind-wing in particular being almost white and marking scarcely visible, with exception of green and black at anal angle.

Exp. 38 mm.

1 ♂. *Hab.* (?).

There is a series of this race from Venezuela in the Adams collection at the British Museum (Natural History) in London, and I have seen others in the Museum at Washington.

Madame Fournier has a single specimen from Muzo, Columbia, which is intermediate between this and the typical form.

***Thecla ortaloides*, sp. n. Pl. IX, fig. 12.**

♂. Differs above from *ortalus*, Godm. & Salv., in being duller in colour and the black margins being narrower. Below the fore-wing has an obscure submarginal dark line, and the hind-wing has the anal red spots considerably reduced.

Exp. 30 mm.

1 ♂. Petropolis, Brazil. 10.ii.1876.

Thecla lilacina, sp. n. Pl. IX, fig. 13.

♂. Nearly allied to *semones*, Godm. & Salv., and *biblia*, Hew. From the former it may be distinguished by the two red and black dots at anal angle of hind-wing below, and from the latter by the deep steel-blue coloration of the upper surface.

Exp. 22 mm.

2 ♂♂. Petropolis, Brazil. ii.1874.

Thecla peculiaris, sp. n. Pl. IX, fig. 14.

♂. Upperside. Fore-wing dark brown, and basal area shining blue; hind-wing shining blue, apex and outer margin dark brown; a large androconial patch just beyond base.

Underside. Fore-wing dull green, inner margin brownish. Hind-wing dull green with irregular dotted postdiscal line; a black spot at anal angle.

Exp. 28 mm.

1 ♂. Petropolis, Brazil. 11.x.1875.

This little species somewhat resembles *smaragdus*, Druce, but may easily be distinguished from it by the conspicuous androconial patch of the hind-wing.

Thecla inconspicua, sp. n. Pl. IX, fig. 15.

♀. Upperside. Fore-wing dull brown, slightly darker towards apex and outer margin. Hind-wing dull brown, an obscure grey line toward outer margin, a dark brown spot on outer margin between the tails, and lobe dark brown.

Underside. Fore-wing grey; an oblique brown line, outwardly edged with whitish, extending from costa to lower median nervule; an irregular submarginal line of grey lunules outwardly edged with whitish. Hind-wing grey, an irregular discal reddish-brown line, outwardly edged with whitish, extending from costa to inner margin; a submarginal greyish line as in fore-wing, a triangular red-edged black spot between tails; lobe black inwardly edged with reddish.

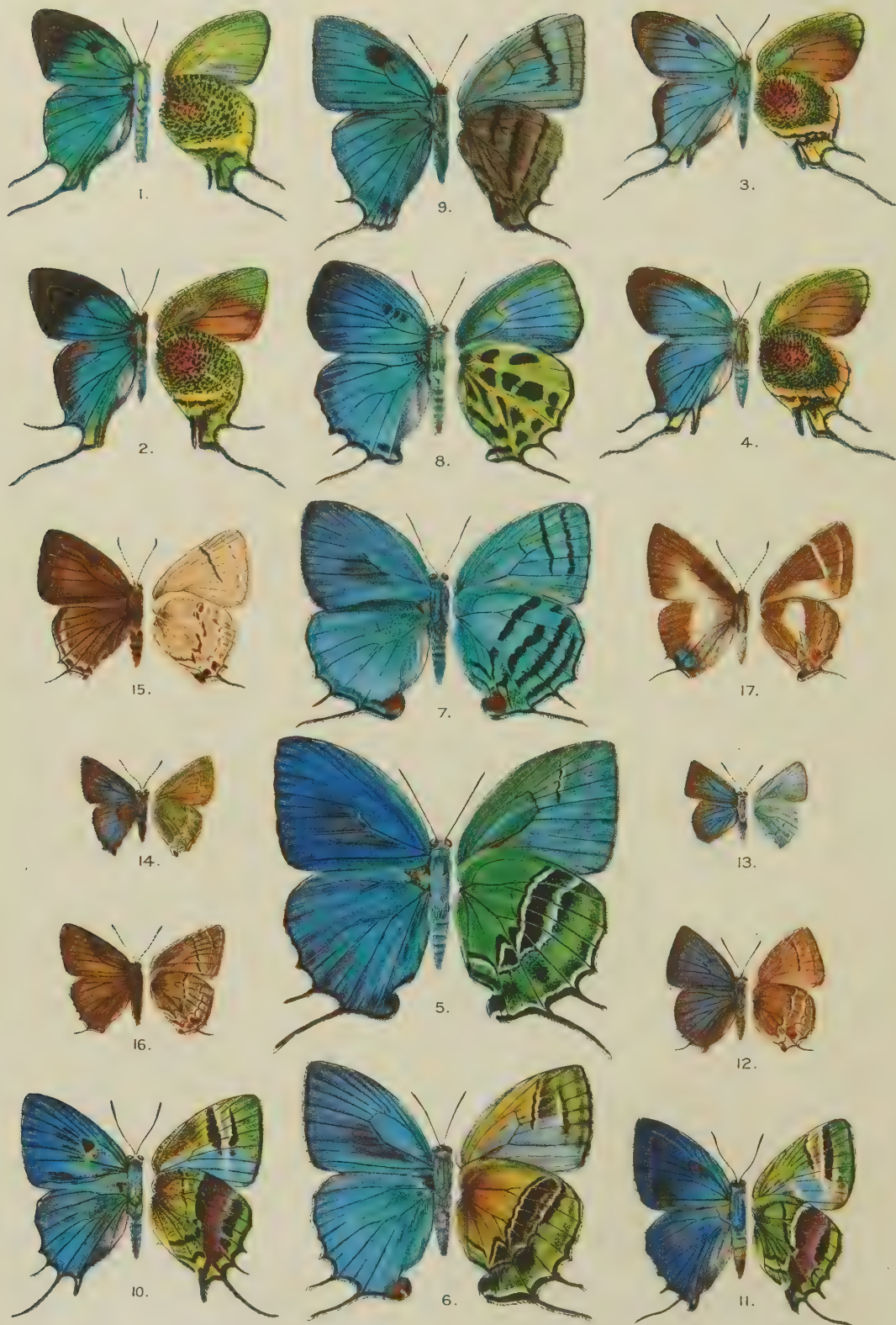
Exp. 40 mm.

Petropolis, Brazil. 28.viii.1872.

This species is closely allied to *basalides*, Hübner, but may be distinguished by the absence of spots near the base of the hind-wing below.

I conclude this paper with a few remarks concerning the late Charles Oberthur's dictum, "Pas de bonne figure, pas ne nom valable." In the course of working out the few species here concerned, on two occasions figures have been useless, as they were not accompanied by adequate descriptions; a description of *T. ducalis*, Westw., pointing out the differences between it and *T. imperialis*, Cram., would have enabled me to identify it without having had to have reference to the type. Had Hewitson mentioned in his description of *T. tagyra* the position of the androconial spots, it would have been quite easy to distinguish between it and the species here described.

In *Ann. Mag. Nat. Hist.*, loc. cit., I pointed out that in one of Oberthur's own works, "Lépidopterologie Comparée," 11, a description of his did not agree with the figure (*Perisama lebasii*, p. 97, f. 2971-74), and suggested that the description was probably correct. Mr. Levick kindly allowed me to see the specimens which are now in his collection, and I found that the figures were incorrect. So we have here the case of the figure being absolutely misleading, and the only way of identifying the species is by reading the description.



Odette du Puygaden.

John Bale Sons & Danielsson, Ltd. London.

EXPLANATION OF PLATE IX.

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- FIG. 1. *Thecla imperialis oakesii*, Butl. ♂. Colombia.
 2. " *ducalis*, D. & H. ♂. " ♀. "
 3. " *gloriosa*, sp. n. ♂. Colombia.
 4. " *cuprea*, sp. n. ♂. Ecuador.
 5. " *tagyroides*, sp. n. ♂. French Guiana.
 6. " *mirabilis*, sp. n. ♂. Ecuador.
 7. " *drucei*, Lathy. ♂. Brazil.
 8. " *draudti*, Lathy. ♂. Colombia.
 9. " *ganymedes*, Cram. ♂. French Guiana.
 10. " *ortaloides*, sp. n. ♂. Brazil.
 11. " *lilacina*, sp. n. ♂. "
 12. " *peculiaris*, sp. n. ♂. "
 13. " *inconspicua*, sp. n. ♀. "
 14. " *tristis*, Lathy. ♂. Matto Grosso.
 15. " *Lamprospilus decorata*, Lathy. ♂. Peru.

COLLECTED RECORDS RELATING TO INSECT MIGRATION : SECOND SERIES

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[Read December 4th, 1929.]

WITH TWO TEXT-FIGURES.

IN continuation of my previous policy, I give herewith a number of new records relating to the migration of insects that have been observed or have come to hand since the publication of my last paper in *Trans. Ent. Soc. Lond.*, **77**: 79-91.

The first four records given here are my own observations at Amani during 1927-1928, and are in more detail than usual, to give those naturalists who have not seen such flights a more definite idea of their nature and of their continuity. Amani appears to be a locality specially favoured for the study of insect migration, and I am at present engaged in trying to build up throughout East Africa a network of interested observers, in the hope that by so doing, and with a small amount of good fortune, it may be possible in the future to trace some of the flights in this part of the world from their source to their goal.

The remaining records have been sent in to me by correspondents in various parts of the world, and I take this opportunity of thanking them for their co-operation.

The following records are dealt with below:—

Records in Africa.

- (1) *Belenois severina* at Amani in December 1927.
- (2) *Catopsilia florella* at Amani in February-March 1928.
- (3) *Andronymus neander* at Amani in March-May 1928.
- (4) *B. severina* at Amani, June-September 1928.
- (5) *B. severina* at Amani on 5th October, 1928.
- (6) *B. severina* at Mbale, Uganda, in May 1928.
- (7) *B. severina* in N.E. Tanganyika on 27th August, 1928.
- (8) *B. severina* in Uganda in May and June 1928.
- (9) *B. severina* and perhaps *Mylothris ruppelli* at Moshi, Tanganyika, in June 1928.
- (10) *B. mesentina* in Koru, Kenya, in February 1926.
- (11) *B. mesentina* at Moshi, Tanganyika, in February 1926.
- (12) *B. mesentina* at Butiaba, Lake Albert, in May 1928.
- (13) *Pieris solilucis* and *Pinacopteryx* sp. in Uganda in June 1928.
- (14) *Rhopalocampa unicolor* in Portuguese East Africa in February 1917.
- (15) *B. severina* and *Catopsilia florella* in Rhodesia.
- (16) *Catopsilia florella* and *Belenois* spp. in the Transvaal.
- (17) *B. mesentina* and *C. florella* in Orange Free State.
- (18) *B. mesentina* and *C. florella* in South Africa.
- (19) *Catopsilia florella* and *Atella phalantha* in N. Rhodesia in 1928.
- (20) *P. helica* in South Africa in December 1926.
- (21) *B. mesentina* in Swaziland in 1927.

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- (22) *B. mesentina* (?) in S.E. Transvaal in December 1926.
- (23) White Butterflies in Zululand in May 1905.
- (24) White Butterflies in Cape Province in 1887.
- (25) White Butterflies in Zululand in February 1928.
- (26) *Terias desjardini* off West Coast of Africa.
- (27) White Butterflies off Cape Verde Islands.

Records in India.

- (28) *L. boeticus* in the United Provinces in March 1928.
- (29) *Achalarus bifasciatus* at Mussoorie in September 1918.
- (30) *Kallima inachus nuegeli*, at Dehra Dun in November 1924.
- (31) *L. boeticus* at Dehra Dun.
- (32) Catopsilias at Dehra Dun.
- (33) DANAINAE at Tavoy, Burma, in January 1920.
- (34) *Crastia core* at Deolali in July 1922.
- (35) Various butterflies at Pachmari in September 1922.

Records in America.

- (36) *Pieris monuste* (?) in Florida in April 1906.
- (37) *Eunice modesta* in British Honduras.
- (38) *E. modesta* in British Honduras.
- (39) *Papilio philolaus* in British Honduras.
- (40) *Gonepteryx macrula* in British Honduras.

Records in Australia.

- (41) Migratory butterflies in Australia.
- (42) *Badamia exclamationis* in Australia.

(1) **Migration of *Belenois severina* with other species at Amani, Tanganyika, in December, 1927.**

In the first week of December, 1927, I noticed a considerable increase in the number of butterflies at Amani, both in species and numbers, without, however, any definite migration. But on the 8th December, about 1.30 p.m., I noticed a definite migration taking place chiefly consisting of small white Pierids.

On a front of about 150 yards the following numbers were counted as passing in successive minutes, all from the N.W. to the S.E.—viz. 16; 14; 13; 9. During this period only one or two passed in any other direction. The sky was about half-clouded. The wind was very light and variable at the ground-level, but the low clouds above were going steadily east to west.

Between 1.30 and 2 p.m. I captured the following insects, all apparently taking part in the flight :—

Belenois severina—three.

Teracolus achine—one.

Terias senegalensis—one.

There was thunder in the S.W. during the flight and the day was oppressive. By 2 p.m. the sky was completely clouded and the migration had ceased. The temperature was then 25° C. (77° F.) and the wet bulb 23° C. (73° F.), giving a

relative humidity of about 84%. On the 9th December there was heavy cloud, rain and thunder most of the morning, but at 2.15 p.m. a slight flight was again noticeable, this time from north to south, with a few going from N.E. to S.W. and one or two east and west. The wind was again light and variable, with the clouds above moving steadily N.E. to S.W. The flight was during sunny intervals with cloud.

In about half an hour I captured :—

Belenois severina—several.

Teracolus phlegyas—one.

Terias senegalensis—one.

Pinacopteryx liliana—one.

Mylothris ruppelli—one.

I also saw several species of *Papilio* flying in the same direction, one of which was probably *P. philonoe*, but I was unable to catch any.

The flight between 2.30 and 3.30 p.m. did not average more than one specimen per minute. Most were *B. severina*, but two or three other *Terias* and one other *Teracolus* were seen. No *C. florella* were noticed.

At 3 p.m. the temperature was 23.5° C. (74° F.) and the wet bulb 22° C. (72° F.), the humidity being therefore 87%. By 3.45 p.m. the migration had ceased.

On the 10th December no migration was noticed, and on the 11th a very few *B. severina* were seen going to S. or S.E. on an estate about seven miles to the north of Amani.

On the 12th December at 1.30 p.m. there was an indefinite migration to the east at Amani. The wind N.E. to S.W., but light and variable. I counted the number of butterflies going for five minutes, but 18 passed in the first two and none in the next three. I captured :—

Papilio philonoe—one.

Belenois severina—two.

The temperature at 2.30 p.m. was 23.5° C. (74° F.) and the wet bulb 21.5° C. (71° F.), the humidity being thus 83%.

After this day no signs of migration were observed. It is interesting to note that the first thunderstorm of the season was on the 7th December, the day before the migration started. Previous to that there had been a little rain in early December, but November had been dry after very heavy rains in October.

The butterflies were all flying at from 4 to 10 feet above the ground, but rose higher over buildings and trees, unless the latter were thin.

One female *B. severina* was dissected and showed well-developed ovaries but no eggs ready to lay.

I am indebted to Dr. Dixey of Oxford for the identification of most of the specimens, and he gives the following information with regard to the seasonal forms :—

Teracolus phlegyas—male of wet-season type.

Teracolus achine—female of wet-season type.

Pinacopteryx liliana—female of intermediate type.

Terias senegalensis—male and female of intermediate type.

(2) Migration of *Catopsilia florella* in North-East Tanganyika in February and March, 1928.

From February 28th to March 9th there was a migration of *Catopsilia florella* towards the N.E. in North-Eastern Tanganyika and South-Eastern Kenya, stretching at least from Amani (about 30 miles from the coast) on the south-west to Tanga on the south-east and Mombasa on the north-east. The following are my notes and a few observations from other observers.

28th February, 1928.—At 11.45 a.m. (the times given are Tanganyika official time, which in the Amani district is about half an hour ahead of local sun time) I noticed a slight migration of *C. florella* at Amani flying more or less from S.W. to N.E. From 11.40–11.50 fourteen were seen on a twenty-yards front all going in the same direction. The weather was hot and the sky almost clear. The wind very slight and more or less behind the flight—i.e. from the S.W. The temperature 26.5° C. (80° F.), the wet bulb 21.5° C. (71° F.), hence the relative humidity was 62%. The direction of the flight as observed with a prismatic compass was 50° E. of N. (magnetic variation, at present about 4° W., not allowed for). One captured was *C. florella*, and in the flight it was easy to see the difference between the deep yellow and the pale specimens.

From 12 midday to 12.10 nineteen passed.

From 12.10–12.20 twenty-two passed.

At 1 p.m. still passing.

From 1.3–1.8 p.m. fifteen passed, mostly pale.

From 1.8–1.13 p.m. six pale and three yellow.

From 1.13–1.17 p.m. five pale and two yellow.

From 1.17–1.23 p.m. seven pale and one yellow.

From 1.30–1.40 p.m. nineteen pale and three yellow.

From 1.40–1.45 p.m. four pale and four yellow.

From 1.45–1.50 p.m. ten pale and five yellow.

At 1.30, when the temperature was about 28° C. (83° F.), a few clouds began to appear and the wind was about S.E. but still very light. By half-past two the sky was completely clouded and the migration had practically ceased. Two specimens were captured, both of which were pale males.

About 2 p.m. an attempt was made to measure the speed of flight by timing specimens over a space of about 100 yards. The following were the times in seconds measured for successive specimens—13 : 13 : 12 : 12 : 12 : 14 : 13. This gives an average of slightly below 13 seconds for 100 yards, or approximately 15.75 miles per hour. The insects were flying from 3 to 15 feet above the ground, but mostly about 6 feet. They rose steadily over obstructions such as houses rather than depart from their direction, keeping about the same height above them as over the ground.

29th February.—At 10.45 a.m. first one seen flying rather wildly, but more or less in same direction as before.

At 10.55 a.m. three going fast to N.E.; continuing about one per minute.

From 11.20–11.30 a.m. three pale specimens.

At this time the sky was about 9/10 cloudy. The wind at ground-level variable, chiefly S. or S.E., but the clouds which were fairly high going E. to W.

At 12.20 still passing about one per minute.

From 1.8–1.13 p.m. five on 25-yards front.

From 1.13–1.18 p.m. seven.

From 1.18–1.23 p.m. seven, all pale.

From 1.23–1.28 p.m. ten, all pale.

At 2.30 p.m. still passing.

From 2.32–2.37 p.m. three pale, one yellow.

By 3 p.m. the sky had clouded over and the flight ceased. There was slight thunder about 4.30 p.m.

1st March.—Cloudy most of the day, but in a few fine intervals a few were passing in the same direction. There was thunder in the afternoon and a heavy storm during the night.

2nd, 3rd and 4th March.—Mostly cloud and rain, practically none seen.

5th March.—To-day I travelled from Amani to Tanga on the coast by motor-car (about 50 miles by road, 30 miles in a direct line). Before leaving Amani, about 9 to 9.30 a.m., a few *C. florella* were already passing. At Sigi, at the foot of the Amani hills, at an elevation of about 1500 feet (Amani is about 3000 feet), the butterflies were flying to the N.E. in large numbers. Sun shining, wind (as shown by the clouds) N. to S. In six minutes (10.13–10.19 a.m.) 155 butterflies passed on a 50-yards front, coming down the valley. Of those that passed in the last four minutes 74 were pale and 24 yellow.

At intervals on the whole journey the butterflies were seen flying, sometimes in numbers, sometimes only very few or absent. They were commonest in the early part of the journey and again near Tanga, and in the last mile into Tanga, at about 1.30 p.m., they were passing at a rate of about 6–10 per minute on a 50-yards front, all going as at Amani to the north-east.

6th March.—At Tanga the butterflies were going in numbers to the N.E. across the harbour as early as 9 a.m. (Tanga time = 8.30 a.m. sun time). The wind was E.N.E., and thus almost against the flight. They were flying only two or three feet above the level of the water. The flight died down shortly after midday when the sky clouded over.

7th March.—Wet most of the day, little or no evidence of migration.

8th March.—At Tanga, from 10 a.m., butterflies going steadily through the town and across the harbour, still to the N.E. although the wind was now S.E. At about 2 p.m. a number were noticed going past the customs house in the proportion of 33 pale to 23 yellow. At 2.45 p.m., when I left Tanga, they were still passing.

9th March : Amani.—A few passing to the N.E. at Amani.

10th and 11th March.—Much rain.

12th March.—A few stragglers only.

This was the end of my personal observations; but, in addition to them, Mr. Wm. Nowell reported that from the 2nd–5th March, while he was on board ship in Mombasa Harbour, the butterflies were continually passing more or less to the north-east.

Further, the Rev. J. W. H. Bullock made the following observations for me at Tongwe, about 10 miles from Amani towards the coast, and at an altitude of about 700 feet.

5th March.—At 11.40 a.m. 69 butterflies in five minutes over a front of about 35 yards. The next five minutes 57 passed, of which 48 were pale and 9 yellow. All were going slightly east of north. Wind very light and variable.

6th March.—At 10.44 a.m. 16 passed in five minutes. Weather bright, wind light N.E. At 11.25 a.m. 10 and 16 in successive five minutes. By this time quite calm and cloudy. Raining by 1 p.m.

7th March.—A few noticed in the afternoon after a wet morning.

8th March.—Migration continued in bright weather. In twenty minutes

from 9.24–9.44 a.m. 69 butterflies passed on the same front as before. In ten minutes at 1 p.m. 28 passed. The wind had gone round to almost due east.

9th March.—Migration going on all morning. Wind S.E.

10th March.—At 9.30 a.m. 26 passed in ten minutes, but by 11 o'clock, with the wind N.E. and getting strong, the flight almost ceased and after noon none were seen.

11th March.—No flight noticed.

12th March.—Small flight. Seventeen in ten minutes at 11 a.m., but an hour later none to be seen. Bright day with northerly wind.

13th March.—No observations made.

14th March.—Slight flight.

15th March.—Slight flight. Thirteen in ten minutes at 10.45 a.m.

16th March.—Nothing noticed, but little time for observation.

In general the Rev. Bullock says that he saw no flight on any day before 8.45 (sun time), and that a fair number, about one-third, were flying high, about 20 feet or more above the ground.

The flight took place just at the end of the dry season and the beginning of the wet. There were only three wet days in February, with less than 4 mm. of rain altogether, but the rains started on the 1st March and were very heavy in the first ten days, after which there was a slight reduction until towards the end of the month. (See Fig. 1, p. 147.)

(3) Migration of *Andronymus neander* at Amani, Tanganyika, in March, April and May of 1928.

In the (1906), *Insektenbörse*, 23: p. 75, Vosseler describes a migration of *A. neander* at Amani on 19th March, 1906. In the *Trans. Ent. Soc. Lond.*, 76: 88, I have recorded a second flight in the same place seen by Mr. Wm. Nowell in April 1927. In 1928 I had the opportunity to see myself a third flight of the same insect at Amani, which is of interest in constituting what is I believe one of the longest continued flights yet recorded, as it lasted more or less continuously, except for wet weather, over a period of about forty-eight days. The following are my notes on the flight.

21st March, 1928.—At 3.30 p.m. (Tanganyika time, about half an hour ahead of sun time) Mr. Nowell called my attention to the fact that a few butterflies were passing, and that he thought that a flight similar to last year might be commencing again. A dozen or more Skippers were seen going fast to the S.W. past Mr. Nowell's house. The wind was light N.E., the sky cloudy after a sunny day, with rain coming up in the N.E. Temperature 25.5° C. (78° F.). The rain started at 3.45 p.m., and no further flight was observed.

22nd March.—Whole day mostly cloudy. No flight seen.

23rd March.—Very definite flight in the afternoon. Between 2 p.m. and 2.30 p.m. in successive five minutes 82, 59 and 54 were counted crossing a 20-yards front. The wind was light S.E., the flight from N.E. to S.W. At 2.50 p.m. the flight still continued, the temperature was 26.5° C. (79.5° F.) and the wet bulb 23.5° C. (74° F.), giving a humidity of 76%. The flight was still on at 3.30 p.m., but ceased with rain about 3.45.

24th March.—In the morning no flight was noticed. Between 1 p.m. and 2 p.m. 10 to 15 were passing per five minutes on front as before. There was thunder and slight rain.

25th March.—Big flight seen about 11.30 a.m. In successive minutes 62, 52 and 35 passed. Sky thinly clouded, almost calm, wind, if any, E. to W. Still going strong up till 12.30, but at 1.30 only 22 in five minutes.

26th March.—Skippers going at 11 a.m. At 11.30 a.m. 45 in five minutes. At 3 p.m. 49 in five minutes. Warm, sunny, no wind. At 4.30 p.m. none.

27th March.—None between 10 and 11 a.m., but by 11.35 a.m. 28 passed in five minutes. Wind slight E.

28th March.—At 10.45 a.m. about one per minute. At 11.30 a.m. 80 in five minutes. Wind light, due east. At 2 p.m. 25 in five minutes. At 4.30 still passing in small numbers. Wind E. or E.S.E.

29th March.—None at 10 a.m. A few at 11.30. Still passing at 12.45 p.m. and 3.45 p.m.

30th March.—Seen going at intervals during the day in small numbers.

31st March.—A few seen at 11.30 a.m. At 1.30 p.m. 73 in two minutes. At 2 p.m. 96 in two minutes. At 3.30 still passing in numbers. At 4.30 thunder and very heavy rain for an hour. Just before the storm, Mr. H. H. Storey caught 7 specimens in his house (about half a mile east of my usual observation post), these having flown in at the windows.

1st April.—Started about 10 a.m., passing in numbers at 10.30. By 10.45 a.m. 155 in five minutes. At 1.30 p.m. still going. At 1.45 in bright sun going in enormous numbers, too fast to count, about 10 per second on a 20-yards front. Ten minutes later it was cloudy and very few passing. They were passing all afternoon in small numbers. Mr. G. F. Clay went by car from Amani to Muhesa (about 15 miles E.S.E.) to-day and saw the Skippers passing in great numbers at Sigi (1500 feet and about 2 miles to east of Amani), and at the top of Langusa Hill (about 2000 feet and about 4 miles east of Amani).

Mr. H. H. Storey at his house (see above) estimated the flight at 60 per minute on a 10-foot front between two trees at 11.30 a.m., going N. to S. The flight ceased about 12.15 and restarted at 1 p.m. By 1.15 they were as common as at 11.30, and at 4.30 they were again observed to be passing on a front of about 200 feet in all, separated by a group of thick trees, at a rate of 60 per minute per 10 foot or about 1000 per minute in all. They were still passing at 5 p.m., but in much smaller numbers.

2nd April.—During the morning, going in large numbers. At 2.30 p.m. "millions"—too fast to count. Bright sun, a few clouds. Flying in an open field from N. or N.N.E. to S. or S.S.E. Wind light and variable, mostly E. and S.E. at ground-level, but lowest clouds going S. to N. At 3.30 still going in thousands. At 4.30 still fair numbers. Light rain at 5 p.m., but a few Skippers still flying in spite of it.

3rd April.—Rain, and cloud most of the morning. At 1.15 p.m. going about 10 per minute, cloudy but no rain. At 1.25 sunny, 5 per second at least. At 2.30 going in thousands. At 4.15 p.m. in one minute 18 passed.

4th April.—Rain and cloud all day. No flight.

5th April.—Already going in small numbers at 9 a.m. with slight sun, but almost immediately after clouded over and none seen. Wind S.E. Small numbers going at 11 a.m. At 12 noon 4 or 5 per second. At 1 p.m. thousands, at 2 p.m. 4-5 per second. At 2.30 main lot of butterflies going S.S.W. as usual, but quite a number going from N.W. to S.E. or even W. to E. Wind at ground-level S.E. to N.W. Low clouds going S. to N. or S.W. to N.E. Five minutes later all were going normally. At 4.15 p.m. still going nearly all N. to S. with a few N.W. to S.E.

To-day Mr. H. H. Storey reported the Skippers in numbers at the top of Langusa Hill (see above), but none at the foot.

6th April.—Going at 9 a.m. in small numbers. At 11 a.m. small numbers

flying in a slight rain. At 11.50 in fair numbers. Wind light S. or S.E. Rain and thunder in afternoon.

7th April.—Moderate numbers at 10 a.m. At 11.15 going in fair numbers but rather wildly, direction not so definite. Wind at ground-level E. to W., but lowest clouds N. to S. A few minutes later sunny, and large numbers in original course, none going S.E. At 11.30 a.m. 467 in six minutes. The temperature was 24° C. (75° F.) and the wet bulb 22.5° C. (72° F.) giving a humidity of 87%. At 1 p.m. 3 or 4 a second passing, too fast to count. Also at 1.20, and at 2.30. The wind was then distinct from S.S.E. or S.E. at the ground, lowest clouds going N.E. to S.W. approximately. At 4.30 they were flying in various directions in a light rain.

8th April.—A few going at 10.45 a.m. At 11 a.m. 63 in three minutes. At 11.30 a.m. 40 in one minute. At 12 noon 140 in one minute. At 1.45 p.m. 83 in one minute. At 3 p.m. 100 in one minute. Sunny, ground wind E. to W., lowest clouds N. to S. Temperature 26° C. (79° F.), wet bulb 21° C. (70° F.), relative humidity 62%. The flight was continuous all to-day for at least four hours, averaging 60 per minute on the 20-yards front, which gives about 12,000 butterflies for the day on this front. By 4 p.m. the numbers had reduced to about 20 per minute.

9th April.—None at 9 a.m. At 11.30 very much fewer and about half going N.W. to S.E., rest as before (*i.e.* N.N.E., or N.E. to S.S.W. or S.W.). At 12.20 about 20 per minute. At 3.30 p.m. about 30 per minute. At 4.15 p.m. 13 in one minute.

10th April.—At 11–12 a.m. small numbers. At 1.30 p.m. 20 and 18 in successive minutes. At 2 p.m. and 3 p.m. still going in fair numbers. At 4.40 p.m. in small numbers.

11th April.—Very few during the morning. At 12 noon I started to count for successive minutes, and the numbers immediately increased. The following are the numbers each minute with the condition of the sun :—

(1) Shade, 1	(6) Sunny, 74
(2) Sunny, 19	(7) Mostly sun, 69
(3) Shade, 36	(8) Clouded, 33
(4) Shade, 49	(9) Clouded, 18
(5) Partly shade, 55	

Still going in fair numbers in the afternoon, 33 in one minute at 4 p.m. All over by 5 p.m.

12th April.—Very few during the morning. At 1.35 p.m. 104 in four minutes. At 2.30 p.m. 82 in two minutes. At 3.15 p.m. 171 in three minutes. At this time the temperature was 27.5° C. (81° F.). The ground wind was slight, S.E. to N.W. The lowest clouds about the same. One or two seen passing at 5 p.m.

13th and 14th April.—Cloud and rain all day. No migration.

15th April.—At 10.20 a.m. 22 in five minutes. Temperature 23.5° C. (74° F.). Ground wind W. to E., lowest clouds S. to N. At 10.45 about 30 per minute. At 11 a.m. 90 in one minute. At 12.30 p.m. 122 in four minutes. At 1 p.m. 60 and 76 in successive minutes. At 1.45 p.m. 70 in one minute. Still going at 2.30 and in smaller numbers at 3.30 p.m.

16th April.—Cloudy with occasional rain in morning. One or two seen at 1 p.m. Heavy rain and thunder in afternoon.

17th April.—None in morning although no rain. Two seen at 2.30 p.m., but shortly after rain commenced.

18th April.—None seen.

19th April.—Migration resumed quite strongly. Between 11 and 12 noon going too fast for accurate counting, say 150–200 per minute. At 1.45 p.m. much the same. Continued, but not so strongly, till 3.30 at least.

20th April.—A few seen about midday to 1.15 p.m.

21st April.—None during morning. At 1.30 p.m. 84 in five minutes, but at 1.45 only 20 in six minutes.

22nd April.—Only one or two seen.

23rd April.—Going about 1–2 per minute at 12.45. At 1.15 p.m. 28 in five minutes.

24th and 25th April.—None passing.

26th April.—At 10.15 a.m. 17 passed in six minutes.

27th April.—At about 11.30 a.m. 40 passed in five minutes. But the flight only lasted for an hour. Heavy rain all afternoon.

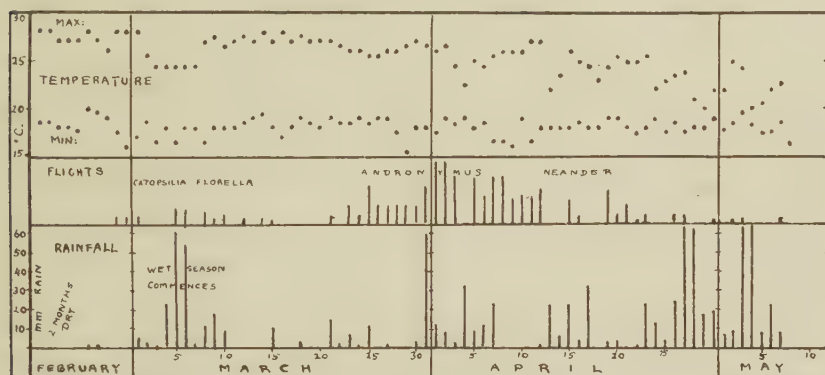


FIG. 1.—Flights of *C. florella*, and *A. neander*, at Amani, Tanganyika, in 1928 with rainfall and temperature during their occurrence.

29th, 30th April and 1st May.—Continuous heavy rain most of the time. No Skippers seen in the very few fine intervals.

2nd May.—Three or 4 seen about 12.15 in first fine interval for several days.

3–6th May.—Continuous bad weather.

7th May.—About 4 per minute at 12.30. Wind S.W. At 1.45 p.m. only 1 seen in five minutes.

These appear to have been the last stragglers of the migration. The weather continued very bad with little sunshine and much mist and rain for the following week.

The flight therefore was actually observed on 34 out of the 48 days from the first to the last observation. All the days on which there was no flight were wet or with heavy cloud. Fig. 1 shows diagrammatically the course of the flight, together with the rainfall and the daily maximum and minimum temperatures. It will be seen that the rains of the wet season started on the 1st of March after two dry months. More or less heavy rains fell during the flight, but on some days most of the rain fell at night, so did not interfere with the flight.

In addition to my own observations at Amani, the Skippers were seen migrating in the same general direction at Bulwa about six miles to the north

of Amani, and at Kwamkoro about six miles to the south. At Tongwe, about ten miles to the east, they were also seen going approximately N. to S. by Rev. J. W. H. Bullock on the 3rd and 5th April. At 1.25 p.m. on the 3rd they were "far too numerous to count." At 9.30 a.m. and 12.30 p.m. on the 5th they were not in such great numbers. Rev. Bullock adds: "I was talking the other day to a well-educated African, educated in England. He has on many occasions noticed a migration taking place, and his idea is that they go down to the coast and change their colour and then come back!!"

On the other hand, I wrote to two friends in the plains about ten miles south of Amani, and neither had seen any migration. But this cannot be taken as definite evidence that the flight did not occur there.

The extreme points at which the flights were actually observed were about ten miles apart in a north and south direction, and about the same distance east and west. The butterflies when migrating flew with a rapid, purposeful, zigzag flight at a height of about three to six feet above the ground-level. (For note on the actual speed see below.) When they met an obstruction considerably higher than their flight-level they usually turned aside from their normal direction and rose obliquely. Thus they would be momentarily considerably deviated from their course by such an obstruction as a house, and would fly along the obstructing wall a considerable distance rather than rise much above their normal height. I never saw a single specimen fly over the roof of a house at Amani, although practically all the houses are single-storied bungalows. This is in marked contradistinction to *C. florella*, which would rise over any house or other obstruction rather than be deviated from its flight direction.

On several occasions the butterflies entered open windows of houses in their path, both in this flight and in the similar one recorded for the previous year (*l.c.* above).

When the butterflies were flying through the plantations, if the trees were not very thick, they would fly between the trunks at their normal level. In the thick virgin forest they rose to about twenty feet high, and flew above the dense lower growth but well below the tree-tops. (This is quite different from *B. mesentina*, which migrate just above the top of the forest trees.) If the butterflies came to a wall of forest directly across their path they would rise obliquely to the higher level and proceed through the trees. If, however, a slight deviation would enable them to keep near the ground they would fly along the edge of the forest block. This habit resulted in a very uneven distribution of the flight. At some points there would be thick streams of insects and at others none at all. It is important therefore to note that when it is stated that the flight was, say, 50 per minute on a 20-yards front, this applies only to the point of observation (which was usually my own garden), and it does not apply to the whole width of the flight.

Speed of Flight.

Vosseler (*l.c.*) comments on the extreme rapidity of the flight, and at first sight the impression of the zigzag flight of the small brown moth-like insects most certainly gives this idea.

I made two attempts to get observations on the speed.

On 23rd March, at about 3 p.m., they were timed with a stop-watch flying over a measured length of twenty yards. The average of 26 records was 3.5 seconds, the fastest 2.8 seconds and the slowest 4.2 seconds. This gives an average speed of only 11.6 miles per hour.

On the 2nd April, in the afternoon, I tried in another spot over a front of about eighteen yards, and seven observations gave an average of four seconds with minimum 3.8 and maximum 4.2. This gives an average speed of only 9.2 miles per hour. Of the two, I believe the former figure to be more accurate, but the speed is thus considerably slower than that of *C. florella* (see above), which averaged about fifteen miles per hour.

Proportion of Sexes and Sex Condition.

At frequent intervals I made random captures to obtain the proportion of the sexes. The following table gives the results :—

Date.	Males.	Females.
March 23rd	7	8
„ 25th	3	5
„ 27th	0	1
„ 28th	2	4
„ 31st	22	17
April 1st	5	4
„ 2nd	8	7
„ 5th	1	10
„ 6th	13	15
„ 7th	27	25
„ 8th	10	11
	98	107

The result is remarkably close to equality of sexes. In fact, apart from the 6th April, when for some unknown reason,* there were 10 females to 1 male, the captures were exactly 97 males and 97 females.

Two females caught on 27th March were dissected and showed a well-developed fat body and also ovaries, but with no visible eggs yet developed.

Weight of Migrants.

It has occasionally been suggested that migration is due to overcrowding and starvation at the point of origin. It occurred to me that some evidence in this question might be obtained by comparing the weights of migrant and non-migrating insects of the same species. As a start in this investigation I weighed on a chemical balance a number of specimens within an hour of killing in a cyanide bottle.

The following are the weights in milligrams according to sex :—

Males.—83, 87, 85, 88, 89, 75, 91, 81, 77, 80, 78. Average 83 milligrams.

Females.—100, 97, 84, 95, 84, 80, 78, 114, 80, 85, 78. Average 90 milligrams.

Up to the present no opportunity has occurred to capture non-migrating specimens for comparison.

Relation of Flight Direction to Wind.

With one or two very slight exceptions, the direction of the flight was

* It is interesting to note that these 11 specimens were captured *inside* the rooms of a house, having entered through the windows.

throughout more or less N.N.E. to S.S.W. The actual records of the wind on various dates extracted from the above notes are as follows :—

March	21st—light N.E.
„	23rd—light S.E.
„	25th—v. light E.
„	26th—none.
„	27th—light E.
„	28th—E. or E.S.E.
April	2nd—light E.S.E.
„	5th—S.E.
„	6th—S. or S.E.
„	7th—E. to W.
	—S.S.E. or S.E.
„	8th—E.
„	12th—S.E.
„	15th—W.
May	7th—S.W.

It will be seen that the first record is slightly N. of east and the last two are S.W. and W., but that during the rest of the flight the wind was between east and south. Whether or not the turn of the wind to W. and S.W. had any connection with the end of the flight can only be seen by collecting more data in the future. At present all we can do is to put the facts on record.

(4) *B. severina* at Amani, Tanganyika, June–September, 1928.

The following is a summary of the notes from my diary :—

11th June, 1928.—Several *Belenois* about last few days have given an impression of migration, so I kept a close watch from 2.50–4.15 p.m. In 1 hour and 25 minutes 30 *Belenois* passed, all going from north-west to south-east. Six of them were captured and 4 were *B. severina* and 2 *B. mesentina*. In addition 18 specimens of *Danaïs dorippus* passed in the same direction and 6 *Papilio demodocus*. Single specimens of *Catopsilia florella*, *Terias* sp., *Teracolus auxo incretus*, *Appias epaphia*, *Crenis* sp. and *Papilio hornimanni* also passed in the same direction, and during the whole period only one butterfly, a single *C. florella*, flew definitely in any other direction, in this case to south. A few *Lycaenids*, *Acraeas* and *Eurytela dryope* were fluttering round, having nothing to do with the main flight.

These figures were counted on a front of about 50 yards. The wind was light south-south-east. The temperature at 3.30 p.m. was 22.3° C. (72° F.). The sky sunny with frequent clouds, and there had been about 0.66 inch of rain the previous night.

12th June.—From 11.15 a.m.—12 midday 24 *Belenois* and 10 *D. dorippus* passed, all the former and all except two of the latter going steadily to south-east; also single specimens of *Terias* sp. and *Papilio demodocus*. In the same period about six brown butterflies believed to be *Atella phalanta* passed rapidly to south or south-west. Some *Terias*, *Acraea* and *Precis* spp. were fluttering round. The wind was south-south-east with some sun. After 12 noon the weather clouded over and by 12.30 p.m. it was raining.

13th June.—Continuous observations were made from 11.10 a.m. to 12.30 p.m. and from 1.15–2.15 p.m. In this period (2 hours and 20 minutes) the

following butterflies were seen all passing more or less definitely to south-east :—

- 71 *Belenois* (nearly all *severina*),
- 9 *Danaïs dorippus*,
- 1 *Danaïs dorippus* v. *alcippus*,
- 3 *Amauris albimaculata*,
- 3 *Terias* sp.,
- 5 *Papilio*? *hornimanni*,
- 1 *Vanessa cardui*,

and several other unidentified species.

In the same period eight *Atella phalanta* (one captured to confirm identification) passed to south or south-south-west. The wind was light south-south-east.

The *Belenois* were moving leisurely, mostly about 2 to 4 feet from the ground, coming steadily up the slope in front of my house, often settling for a minute or two on small flowers (chiefly Compositae) and then resuming their flight. On two or three occasions I saw one go right up the face of a small conifer tree about 20 feet high, over the top and down the opposite side, keeping about 2 feet from the tree, when a detour of a few feet would have enabled it to reach the same point much more rapidly.

The *Atella phalanta* were going much faster and at a height of 4 to 8 feet.

14th June.—Slight evidence of a few *Belenois* and *D. dorippus* going as yesterday, but no time available for continued observation.

15th June.—Cloudy all day.

16th June.—No observation.

17th June.—Fine morning, almost clear sky, light south-east wind. Observations made 10.45–11 a.m. and 11.30–12 noon. In the 45 minutes there passed 17 *Belenois* including both *severina* and *mesentina*, 10 *Danaïs dorippus* (most to south or south-east) and odd specimens of a few others.

21st June.—Observations made from 1–1.15 p.m. only. Sunny at first, then cloudy. Wind east or east-south-east. Rain at 1.20. In 15 minutes there passed :—

- 9 *Belenois severina*—all to south or south-east,
- 7 *Danaïs dorippus*—3 to south-west and 4 to south-east,

and single specimens of a few other species.

22nd June.—At Muhesa (between Amani and the coast) no trace of directional movement.

26th June.—At Amani in one hour (1.40–2.40 p.m.) there passed :—

- 25 *Belenois severina*—all to south-east except one to north-east,
- 12 *Danaïs dorippus*—to east or south-east except one to south-west.

Occasionally other species apparently going in the same direction, but *Junonia clelia* and *oenone* and *Acraea* and *Terias* fluttering round taking no part. Ground wind from east.

29th June.—In one hour 10.20–11.20 a.m. the following passed :—

- 13 *Belenois severina*—all to south-east,
- 4 *Danaïs dorippus*—all to east or south-east,
- 3 *Mylothris ruppelli*.

Fine and sunny throughout. Wind south-east.

4th July.—Between 1.18 and 2.18 p.m. 20 *B. severina* passed. Of these 17 were going to south-east, two to east and one to west. In the same period 10 *C. florella* passed to south-west and one to south. Other species passed, but there was no definite evidence of directional flight.

The period was nearly all sunny. Wind gusty from south-east. Temperature probably 72–74° F.

5th July.—Bright and sunny, wind from south-east. At my house on a 50-yards front between 1.15 and 1.45 p.m. 77 *B. severina* passed almost all to south-east, one or two only to east or south, and one to north-east. This was the most definite flight observed so far. In the same period 7 *C. florella* passed to south or south-west and one to north.

In addition to the above 1 *V. cardui*, 3 *D. dorippus* and 3 *Junonia oenone* passed to south-east, but none were in sufficient numbers to justify considering them as migrating.

The migration was also proceeding quite definitely at the meteorological station about half a mile to the north-east of my house at 2.15 p.m. and at my house at 3 p.m.

6th July.—In half an hour (1.5–1.35 p.m.) 30 *severina* passed, all going east or south-east. There was much cloud, and they all passed in sunny intervals. Wind south-south-east. In the last fifteen minutes 9 *Precis oenone* passed in the same direction.

10th July.—From 11.30–12 a.m. 7 *severina* passed all to south-east. Sunny. In afternoon from 1.30–2 p.m. 26 females and 9 males passed all to south-east.

11th July.—By midday numbers going past. From 1.25–1.40 p.m. 73 *severina* passed, all to south-east. From 1.40–1.55 p.m. 86, and from 1.55–2.10 p.m. 149, all on 50-yards front. Only about one-third of the time was sunny, and butterflies were going steadily even when sun completely covered with cloud. Still passing in fair numbers at 3 p.m. and in small numbers at 4 p.m. Nearly all within 10 feet of the ground, only one or two about 20 feet. Direction of flight very definite to-day, and many specimens beating themselves against the white wall under my verandah, then retreating a little to avoid the verandah roof, but again striking the wall just above the verandah roof. (See Fig. 2.)

On this day a very thick flight was reported in the same direction at Kwamkoro house about 5 miles to south of Amani. They were flying past, according to Capt. E. Nicholl, in groups of 100 or more from 12 noon to 2.30 p.m.

12th July.—Morning cloudy and cool. Flight distinct in afternoon, and seen on Derema Estate about 3 miles to north of Amani.

13th July.—Flight quite distinct. Mr. G. F. Clay reported 22 butterflies in two minutes on a 30-yards front.

14th July.—Flight thin but definite. Seen at Muhesa (about half-way between Amani and the coast) by Mr. G. F. Clay going along the railway towards the coast (more or less east-south-east).

15th July.—Only a few passing.

16th July.—Very distinct flight. At 12.30, 34 in four minutes. At 2.45 p.m., 55 in six minutes on a 40-yards front, wind south-east, thin cloud.

17th July.—At 11.30 a.m. 100 passed in five minutes. At 11.55–12.10 p.m. 350 passed in fifteen minutes on a 40-yards front. This is the highest yet recorded in this flight. Mostly sunny, wind south-south-east—course more easterly, coming in waves, sometimes none in sight, at other times 15–20 visible at one moment. Nearly all 3 to 8 feet from ground, but a few up to 20 feet.

Many passing at 1.30. At 2.30 p.m. 77 in five minutes. At 4.30 still passing in fair numbers.

18th July.—Between Amani and Muhesa (25 miles by road) butterflies seen at intervals, all flying steadily. At Muhesa railway station 136 in fifteen minutes on a 60-yards front, all going steadily east-south-east.

19th July.—Fair numbers at Amani.

20th July.—At Amani at 10.45 a.m. 119 in fifteen minutes. Mostly sunny, wind south-east. Passing all day. At 3.25 p.m. 39 in five minutes. Cloudy, wind south-east.

21st July.—Already migrating at 9.15 a.m. At 9.30 a.m. 28 in five minutes. At 11 a.m. 140 in ten minutes on a 40-yards front, going south-east or east. Sunny and warm, wind light south-east. At 12.15 p.m. 110 in five minutes.

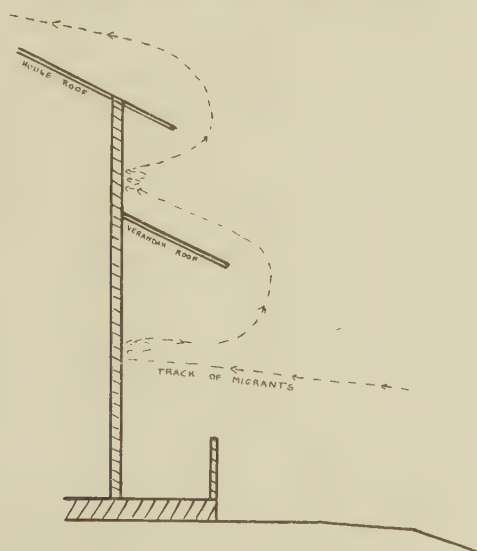


FIG. 2.—Course taken by migrating *B. severina*, when their path to S.E. was obstructed by a bungalow with a low front gallery.

At 2.30 p.m. 129 in five minutes. At 3.30 p.m. going in fair numbers. At 4.15 p.m. only one in five minutes. Temperature 21° C., practically no wind.

22nd July.—Many at Amani. Also seen at Langua about five miles east of Amani.

23rd July.—A few only. Mostly cloudy.

24th July.—Passing in small numbers.

On July 25th I left Amani and did not return until August 18th. During this period, according to two observers, the butterflies continued to drift past. The numbers were quite noticeable for the first week, but after that only a few and possibly going rather more to the east.

19th August.—From 11–11.15 a.m. 25 *severina* passed on a 25-yards front nearly all to east, a few to south-east and north-east. The flight continued thinly.

20th August.—Slight evidence of migration in morning. At 2.30 p.m. 64 passed in fifteen minutes, nearly all of which were in the first five minutes. Flying to east. Weather cloudy, almost calm. Temperature 71° F.

21st August.—Steady drift all day at Amani. Also seen by R. E. Moreau at Ngambo, about five miles to north, coming up steep escarpment from valley below. The escarpment is well over 2500 feet in height, and they were seen at an altitude of about 3500 feet.

22nd August.—Cloudy and wet—none seen.

23rd August.—A few about midday, but mostly wet.

24th August.—Rain, and mist all day—no sign of migration.

25th August.—Morning mostly wet, but small numbers going east in every fine interval. At 2.30 sunny for a short spell—33 passed in five minutes to east, ground wind light from south-east; by 2.50 cloudy again and flight ceased.

26th August.—At 11 a.m. 25 in fifteen minutes, partly sunny, wind light south-east. From 11.15–11.30 a.m. 112 passed. From 11.30 a.m. on, going in fair numbers. At 3 p.m. 186 in fifteen minutes; a few at 4 p.m.; one or two only at 4.45 p.m. although still sunny. This was the first bright sunny day since my return to Amani.

27th August.—Very few in morning, but about 1 p.m. passing in considerable numbers—20 to 30 sometimes in sight at once. From 1.15–1.35 p.m. 208 passed, or 10 per minute on a 25-yards front. Flight definitely to east, wind fairly strong from south-east, alternating clouds and sun. Flight continued till about 4 p.m. During the last four or five days large numbers were also observed passing the manager's house at Kwamkoro about six miles south of Amani.

28th August.—Small flight all day. Maximum 14 in one minute, but usually only one or two.

29th August.—Rain in night and nearly all day.

30th August.—At 9.30 a.m. a few already going. At 10.30 a.m. 134 butterflies passed on a 20-yards front in ten minutes. Wind light to moderate from south. At 11.35 a.m. 339 passed in ten minutes, which is the highest count reached since July; sunny with occasional cloud, wind light south-east. At 12.15 p.m. in five minutes 199 passed. Still going at 4 p.m. 10 per minute, at 4.35 p.m. one or two per minute only.

Seen to-day in numbers by Mr. G. F. Clay in the plains between Korogwe and Muhesa.

31st August.—A few passing between 9 and 9.30 a.m. At 12.10 p.m. 96 in ten minutes. Passing in dozens at 3 p.m.; one or two per minute at 4.30 p.m.

During the last three days they were noted as abundant at Tongwe, about ten miles east of Amani, by Rev. Bullock.

1st September.—Noted in small numbers.

2nd September.—At Tanga on the coast only very slight evidence of migration.

3rd September.—Passing in small numbers at Amani in afternoon.

4th September.—At 10.15 a.m. small flight although cloudy. At 11.20 a.m. steady but thin stream.

5th September.—Only a few at Amani, although sunny. Seen in fair numbers at Kwamkoro by two observers.

6th September.—Mostly cloudy, only a few seen, but these going steadily.

7th September.—Rain and cloud—none seen.

8th September.—Slight but distinct flight for a short time in afternoon only.

9th September.—Slight but distinct flight—2 or 3 per minute—past Derema house, about two miles north-east of Amani, about 3.30 p.m.

10–11–12th September.—Practically none seen.

During the next week occasional specimens were seen going mostly to east or south-east, but it may be considered that the definite flight ceased at Amani on or about 9th September, having lasted for three months.

Sex Ratio.

On several occasions during the period of migration careful counts were made of the proportion of the two sexes passing. The results were as follows :—

	Date.		Males.	Females.
June	26th		8	9
„	29th		8	4
July	10th		9	26
„	11th		27	44
			45	41
			13	22
„	16th		15	31
„	17th		62	38
„	21st		71	53
August	19th		12	13
„	26th		14	10
			66	38
„	30th		75	33
Total			425	362
Percentage			54.0	46.0

The ratio showing a slight preponderance of males.

Sex Condition.

On two occasions dissections were made of females to find the condition of development of the ovaries.

About 12th July three specimens dissected showed ovaries moderately well developed, but it is doubtful if the eggs were ready to lay.

On 26th August five females dissected showed three with ovaries well developed and eggs ready to lay, and two others with the ovaries slightly less developed.

Speed of Flight.

On two occasions observations were made on the speed of flight.

On 12th July 25 individuals were timed with a stop-watch over a distance of 25 yards. The fastest time was 5.4 seconds, the slowest 10.4, and the mean time 8.5 seconds. This gives an average speed of 6 m.p.h., a maximum of 9.4 and a minimum of 4.9 m.p.h.

On 17th July 10 specimens timed over 25 yards gave an average of 7.94 seconds, the slowest being 8.8 and the fastest 7.4. This gives an average speed of 6.4 m.p.h., a maximum 6.9 and a minimum of 5.8 m.p.h.

General Notes on the Flight.

The flight lasted from about 10th June to about 10th September, *i.e.* for three months, with two maxima, one in the middle of July and one at the end of August. The direction in the first month and a half was definitely to south-

east, but later became more easterly. The wind throughout the flight was almost always south or south-east (the south-east Trade winds), but shortly after the end of the flight the wind began to move round to east and north-east with the advent of the north-east monsoon. The insects were nearly all flying about 4 to 6 feet from the ground, with only occasional specimens up to 20 feet. The flight was slow, with frequent stopping at flowers. In the early part of the flight a number of other species seemed to be joining in, but in small numbers. Particularly may be mentioned *Danaiida chrysippus* var. *dorippus*, which on some days in June was in appreciable numbers, but later the flight consisted entirely of *B. severina*. During the whole of the three months scarcely a single specimen of *B. severina* was seen flying in any other direction. The flight was usually strongest during sunshine and died away when clouds covered the sun, but on some days the flight was quite definite although cloudy. The flight was established over an area from about 10 miles south of Amani to about 6 miles to the north, and from a little west of Amani to Muhesa, which is about 15 miles to south-east. See also record by Lee in West Usambara Hills (below) for the same species and period (No. 7).

(5) *B. severina* at Amani, Tanganyika, on 5th October, 1928.

Mr. S. J. Nutman reported to me on 5th October, 1928, that he had seen a small flight of white butterflies flying to the south past his house (Kiumba) at Amani between 1.30 and 2 p.m. Altogether he considers that about three hundred butterflies passed in about half an hour, there being usually one to five butterflies visible at any one moment. The butterflies were coming up a narrow valley leading to his house from the north, flying under the trees near the ground, and rising over his house if it happened to stand in their way. The wind, if any, was light from the east.

I went myself to the spot about 2.30 p.m., but only an occasional specimen was passing. Mr. Nutman caught one which was a male of *B. severina*, and the few that I saw were almost certainly the same species.

This flight appears to have been of short duration and localised on a narrow front, as none were seen passing at my own house or at the laboratories about half a mile to the west.

(6) *B. severina* at Mbale, Uganda, in May 1928.

Mr. N. S. Haig informs me that a flight of butterflies was seen at Mbale on the western slopes of Mt. Elgon, Uganda, which started about a week before the 23rd May, 1928, and was still continuing on the 23rd. The direction of flight was consistently towards the S.S.W. It appeared to commence about 9 a.m. and to continue throughout the day except during rain. The period was in the middle of quite heavy rains, with 6.5 inches of rain in May up to the 23rd. The prevailing wind was from N.N.E. to S.S.W.

Mr. Haig sent to me ten specimens which were all *B. severina*, nine males and one female.

(7) *B. severina* in N.E. Tanganyika on 27th August, 1928.

Mr. Lee tells me that on 27th August, 1928, he encountered two flights of white butterflies. The first about 11 a.m., which was a thick swarm on a front of about 4 or 5 miles and passing about 60 per minute within sight. This was at Bagah near Lushoto in the West Usambara Hills, N.E. Tanganyika.

In the afternoon of the same day in the plains at the foot of the hills he drove through another swarm, not so thick, between Mombo and Korogwe.

Mr. Lee brought me two specimens, one from each swarm, and they were one male and one female of *B. severina*.

(8) *B. severina* in Uganda in May and June 1928.

I received no fewer than five separate accounts of this flight, four from Messrs. C. A. Hoare, W. C. Simmons, R. Fyffe and Dr. G. Hale Carpenter in Entebbe, and one from Mr. Liebenberg in Kampala.

According to Dr. Carpenter the flight started on 28th May in Entebbe and lasted for about ten days in a south-westerly direction against the wind, which is usually between south-east and south-west.

Mr. R. Fyffe first noticed the butterflies on 30th May, and states that they continued intermittently up to 7th June with a few stragglers on 8th June. The direction of the flight was to the south-west.

Mr. W. C. Simmons, writing on 2nd June, states that "during this week" the butterflies had been passing to the south towards the lake at the end of the Entebbe peninsula. On 2nd June they were passing singly, or two or three a minute across his garden. They flew low, 6 to 10 feet, and rose over bridges and trees. "Some went over my house and some got mixed under the verandah." He estimates the proportion of light (males) to dark (females) as about 12 to 1.

Mr. Hoare first noticed the flight about 11.30 a.m. on 31st May, a steady stream flying singly till about 4 p.m. They were flying south-west (by compass determination) against a fairly strong wind from the south. They were also seen all along the Entebbe-Kampala Road. On 1st June only a few stragglers. On 5th June drifting in small numbers to south-west between 3 and 4 p.m. Wind about south. On 6th June large numbers in same direction from morning till about 4 p.m. On 7th, as on the 6th, but smaller numbers. On 8th June none seen in the morning, but in fair numbers about 2 p.m. On 9th and 10th small numbers in the afternoon. On 11th June, none.

At Kampala Mr. Liebenberg writes that about 12 o'clock on 4th June the butterflies appeared round his house flying due south against a counter wind of about 12 miles per hour. In open places they were flying close to the ground. They were not in a great hurry, and an occasional one was seen to take a little food. Across a front of about 20 yards he counted the following numbers passing in periods of four minutes :—

About 12.30 p.m.—200.

„ 12.45 p.m.—110.

„ 1 p.m.—114.

Just after this—130.

About 1.20 p.m.—200.

Averaging about 150 per 20 yards per 4 minutes.

They continued at this rate until about 2 p.m., but by 2.30 almost all had gone except for occasional stragglers up to about 5 p.m.

The flight was apparently several miles broad. The white males were about twice as common as the dark females.

On 5th and 6th June a few were passing steadily throughout the day.

All the above observers sent me specimens of which practically all were *Belenois severina* as follows :—

			Males.	Females.
Mr. Simmons	.	.	5	1
Dr. Carpenter	.	.	18	8
Mr. Hoare	.	.	3	1
Mr. Fyffe	.	.	12	0
Mr. Liebenberg	.	.	3	4
Total	.	.	41	14

The females were all very dark and the males very heavily veined beneath.

In addition Mr. Hoare sent two small *Acraea* sp. and Mr. Fyffe one *Terias* sp., but these, I think, must be accidental captures.

(9) *B. severina* and perhaps *M. ruppelli* at Moshi in June 1928.

Mr. H. L. Brett wrote to me from Msinga Estate, near Moshi, Tanganyika Territory, on 18th June, 1928, as follows :—"There has been another continuous procession of butterflies passing this estate to-day. They were travelling as usual from west to east and flying rapidly without halt, which made it difficult to catch them without any nets. However, I put all the men and boys on the job and managed to obtain the enclosed specimens. I have not seen a flight for some time now, possibly because we have had almost incessant rain up here. To-day has been the first bright sunny day for some time."

The specimens sent were three males and one female of *B. severina*, and three males and three females of *Mylothris ruppelli*. The former is a well-known migrant, but the latter has only once been mentioned in connection with migration, when I captured a single specimen in a migration of *B. severina* and possibly other species at Amani in December 1927. (See above.)

In answer to a further inquiry Mr. Brett writes : "With regard to your suggestion that *Mylothris ruppelli* were merely local and not migrating, I must confess that I had some doubt myself, and I spent some time watching them pass. However, I came to the conclusion that they were migrating, and another fact that rather points to this is that normally I do not see many of this species about, but on that day there were literally thousands of them, and they seemed to be passing from west to east just as were the *Belenois severina*.

"On 18th June there was a very light breeze from (approximately) south-west. . . . I think I am right in saying that I saw them passing the following day, but usually the flight is over in one day."

(10) *B. mesentina* in Koru, Kenya, in February 1926.

Dr. V. G. L. van Someren of Nairobi sends me the following letter, written at Koru, Kenya, by Dr. H. L. Gordon on 4th February, 1926, with the information that the insect referred to is *B. mesentina* :—

"I made the following observations to-day :—

Direction of flight—west to north-west by west.

Direction of wind—westerly; calm to fresh (Beaufort) : very variable.

Number passing a line (north to south) 25 yards within one minute :—

1st observation,	33 (wind moderate).
2nd ,,	72 (calm).
3rd ,,	53 (wind gentle).

This is the fifth day of the flight here. Objective, I think, is clearly west; flight tends north-west as the wind increases. No southerly tendency whatever. Steady stream every day.

“On 2nd inst. I saw a scattered flight at Tunnel Station; a few : direction the same —? left outside wing of this flight. On the same day none whatever seen between here and Tunnel Station by rail.”

(11) *B. mesentina* migrating at Moshi, Tanganyika, in February 1926.

Mr. A. E. Haarer, District Agricultural Officer at Moshi, Tanganyika, gives me the following note :—

“1926, February, millions of white butterflies migrated and passed over New Moshi [at foot of Mt. Kilimanjaro] like snowflakes. The migration lasted nearly a fortnight, but was most noticeable during the first week. Direction of flight—from north-west to south-east. The migration extended from Mondul Mountain, West Meru (possibly further west still), to Kilewo, East Kilimanjaro, *i.e.* in breadth about eighty miles. I have never seen a sight like it. The direction of the wind at New Moshi was from the south-south-east, so the insects were travelling almost against the wind. They travelled during the day, and the Moshi wind is strongest in the evenings. They flew mostly a foot or two above the ground, rising to pass over hedges and bushes.”

This is no doubt part of the great flight that passed over the Nairobi district in this month.

(12) Migration of *B. mesentina* at Butiaba, Lake Albert, Uganda.

Dr. G. D. Hale Carpenter kindly gives me the following record :—

On 4th May, 1928, he landed from the steamer at Butiaba on the east margin of Lake Albert. At this point the escarpment is several miles back from the edge of the lake, the intervening land being flat, rather dry, open bush country, rather suited to Pierids. At Butiaba there is a long sandspit, hooked at its tip in a right angle or more acutely. When he landed at 10 a.m. there was a steady flow of *Belenois mesentina* along the spit and out over the lake in a direction approximately N.E. It was a bright sunny morning, with light air from the west. Two specimens were captured, both males, and he thinks males preponderated in the flight. As he left the spit and motored towards the escarpment, he noticed that although there were numbers of *Belenois* flitting about in the usual way there seemed to be no definite migratory movement here; nor was there at their camp on the top of the escarpment, about twenty-five miles south of Butiaba.

The heavy rains had been well established in the district for a month or more.

(13) *Pieris solilucis* and *Pinacopteryx* sp. in Uganda, June 1928.

Dr. S. Wayland, Director of the Geological Survey of Uganda, sends me the following interesting record :—

“On the 25th June, 1928, I was travelling by car from Hoima to Kampala,

and at mile 120 (from Kampala) I ran into a swarm of butterflies which were clearly migrating towards Hoima (*i.e.* travelling to the north-east) against the wind, which was low. The swarm continued with interruptions of density to mile 106, after which it came to an end almost suddenly. At mile 104½ there were small scattered groups (twos and threes) of the same kind of butterflies, which seemed not to be migrating at all. These small groups continued for 10 miles (mile 94), after which there was a gap of about three miles and then another migrating swarm for about half a mile. From there to mile 54, where I camped for the night, a few scattered butterflies were seen—most of them were lying dead on the road.

"The migrating butterflies were nearly all white (Species A), but a very few were yellow with black-edged wings (Species B). Another large butterfly was occasionally seen (Species C), which clearly was not migrating."

He adds that the paths taken by the migrating insects was not an approximately straight line, but very irregular although steadily leading in one direction.

Dr. Wayland sent specimens as follows :—

Species A (three specimens) was *Pinacopteryx* sp. near *vidua*.

Species B (two specimens) was *Pieris solilucis*, both males.

Species C (one specimen) was *Papilio demodocus*.

The two former species were kindly identified by Dr. van Someren.

(14) *Rhopalocampta unicolor* in Portuguese East Africa.

Mr. G. Arnold, Curator of the Rhodesian Museum at Bulawayo, informs me that in February 1917 he observed a flight, lasting at least an hour, of the Skipper butterfly *Rhopalocampta unicolor*, Mab., in the Amatongas Forest, Portuguese East Africa, going from south-east to north-west. They were so numerous, that he estimated at the time that at any moment there were at least three specimens within any cubic yard of air.

(15) *Belenois severina* and *Catopsilia florella* in Rhodesia.

Mr. G. Arnold tells me that in several different years he has observed a swarming of two species of butterflies in Southern Rhodesia, usually a month or six weeks after the first good rains, that is more or less within the first two weeks of December. The two species are *Pieris* (*Belenois*) *severina*, Cram., and *Catopsilia florella*. As far as he can remember both species were swarming or migrating at the same time, but the *florella* always in the majority. In all cases the direction was to the south-west.

(16) *C. florella* and *Belenois* spp. in the Transvaal District.

Mr. N. C. Kenway gives me the following information for that part of the Union of South Africa which he describes as lying east and north of a line drawn from 24° S., 27° E., to 32° S., 30° E., This includes the greater part of the Transvaal, Swaziland, and part of Natal.

"Over the whole of this area, excluding the coastal belt S.E. of the mountains, the direction of migration appears to be almost uniformly N.E. with occasional N. and N.N.W. deviations.

"The species most noticeable in these flights are *C. florella*, *P. severina* and *P. mesentina*.

"*C. florella* usually starts with a migration of males about the second week of December. This is usually followed by a mixed flight of males and white

females. Gradually the number of males decreases, until by March the flights consist of females with a few males.

"As the season becomes later the yellow females, which appear in small numbers in December, gradually increase until they outnumber both males and white females combined. There is comparatively little migration during drought years. Flights last anything from a few hours to three or four days, and are commonest and of the greatest magnitude in February, March and April, continuing in favourable seasons into May. The last two great migration years we have had for all Pierids were 1917 and 1925, both years of heavy autumn rains.

"*Pieris severina* and *mesentina* are the species which supply the largest flights. Not only do they appear in far greater numbers than any other Pierid, but the flights are apparently over longer distances and of a greater duration. I do not think it is safe to dogmatise as to the season of migration, as I believe that rainfall is the determining factor."

(17) *B. mesentina* and *C. florella* in Orange Free State, S.A.

Mr. H. E. Irving gives me the following information :—

"The only outstanding instance I can recollect occurred some years ago, probably during February or March in the year 1921 (but I kept no record and so cannot be absolutely sure), when millions of *Pieris mesentina* (Cram.) and *Catopsilia florella* (Fabr.) flew over the town [Bloemfontein] from west to east, taking some hours to pass, so that as far as the eye could reach the air was full of them. As far as I can remember there were a few *Colias electo*, L., with them, but the vast bulk consisted of the two species mentioned above.

"I have been in the habit of watching for these waves, because they often bring with them one or two specimens of the rare *Teracolus agoje* var. *bowkeri* (Trimen)."

He also gives me the following extracts from a letter that he wrote on 11th December, 1919 :—

"*P. mesentina* is certainly more numerous in the Orange Free State this year [1919] than usual—these butterflies appear to come to us in waves from the west and to travel in an easterly direction, never remaining in one spot for more than a day or possibly two. I have noticed three such waves recently passing over Bloemfontein and Brandfort, i.e. first week in November, 29th and 30th November and 8th December.

"Their arrival is generally preceded by a heavy west wind. After one or two days they disappear (all but a few stragglers), but in a short time they are as plentiful as ever (fresh arrivals), and generally they tend to fly in an easterly direction. Males and females feed greedily together on various flowers and flowering bushes, but there is little or no courtship, and I personally have not seen any females ovipositing."

(18) *B. mesentina* and *C. florella* in South Africa.

Mr. H. L. L. Feltham, F.E.S., of Johannesburg, kindly gives me the following information with regard to migration in South Africa :—

"I lived on the eastern edge of Kimberley for a number of years between May 1884 and February 1893. During that time *Pieris (Belenois) mesentina* and *C. florella* always appeared in the summer of any ordinarily good season, and when they were fairly abundant always trekked due east toward the Orange

Free State border. I recall no great swarms, but there was generally a sufficiently marked east movement to attract attention. My note-books of this time and of my early years in Johannesburg got mislaid and lost during the Boer War.

"I have had a good opportunity of watching flights of the same two species (both male and female *florella* joining in) since 1910, when I went to live on the northern edge of the Witwatersrand, a suburb of Johannesburg called Houghton Estate, my house being some 200 feet above the veldt below with a steep rocky hill fall. Here I have noticed in many seasons the above insects sometimes in abundance, sometimes not, travelling from south-west to north-east, *i.e.* roughly in the direction of Pretoria. The occurrence is so common, at least once in every decent wet season (summer), that I do not find any exact record in my notes about it, except as to one very heavy flight of both *mesentina* and *florella*, which was so thick as to attract general attention by the inhabitants of the town. Great numbers were seen in the shrubs. My notes in my field note-book are as follows:—

"*March 18, 1915.*—We had record rains in November and December, and January is far above the average, being beaten only by one extreme record.

"*'During the last two months we have had a lot of butterflies out. In January, on the 21st, there was a travelling swarm of butterflies, which, contrary to the usual custom, travelled westward, the regular course being almost invariably from south-west to north-east.'*

"On the next page a cutting is inserted which gives a correct account of the flight.

"The cutting is from *The Leader* newspaper, the principal Johannesburg daily at that time, dated 22nd January, 1915, which I had preserved. The essential remarks of the writer, whom I did not know, are:—

"*'Just before the rain began to fall yesterday afternoon, an enormous swarm of white butterflies invaded Yeoville and Berea [two districts of Johannesburg lying south of Houghton and extending from south-east to south-west of my house], and in fewer numbers, Parktown West [some two miles or more west of my house], at the lunch hour, travelling due west. Smaller swarms have been reported from various other suburbs during the last few weeks. Yesterday's white-winged aerial army was so large and so dense as to remind one of the record Lepidoptera flight of last March, when the busiest parts of the town were invaded. On that occasion the flight was in an easterly direction. A similar flight was recorded in 1911. . . .*

"*'The butterfly is of the same well-known family as the cabbage white. Our visitor of yesterday is known to entomologists as "*Pieris mesentina*."*

"*'The reason for the incursion is probably to be found in the acceleration of the hatching-out from the pupa due to the warm rains, alternating with hot weather.*

"*'Why are the butterflies going west? We can only speculate. The "Great Yellow" always travel north-east. In this species the male is of sulphur colour and the female orange, and they are known to friends of theirs as "*Callidryas florella*." They may make a circle somewhere, but, so far as is known, they always travel north-east, even against a wind. Another acquaintance of ours, "*Acraea aglaonica*," has different ideas and invariably travels in a south-westerly direction.*

"*'The white butterfly which called on us yesterday is one of the commonest of the family of whites, and its ideas of direction are not consistent.'* [Quotation ends.]

"My own notes continued. 'Later on in February there was another very considerable flight of *P. mesentina* and *C. florella*, this time from south-west to north-east.'

"I have myself seen and taken both *A. aglaonica* and *A. buxtoni* in or near Johannesburg in perfectly fresh plumage in the coldest part of our dry season, the former in two or three seasons, the latter once in a park, where there was hoar-frost on the flowers they were sitting on, half dead with cold. Yet both belong to the lower country to the north of the Rand, and their homes are far away. They were not migrating at the time. Perhaps resting only. What made them come?"

(19) *C. florella* and *Atella phalantha* in N. Rhodesia in 1928.

I am indebted to Mr. L. H. G. Mee for the following record. Writing from Samfya, Lake Bangweolo, Fort Rosebery, N. Rhodesia, on 30th October, 1928, he says:—

"On the 29th inst., here, I witnessed a migration of butterflies. The flight was first noticed about 12 noon and lasted till 4.30 p.m. I do not think the flight began earlier, as I should no doubt have noticed it, the line of flight being directly across the front of my house. On the 21st, 22nd and 23rd inst. the weather had been hot and close, the sort of weather preceding a thunderstorm. No wind. On the 24th inst. it became cloudy, cooler, and there was rain—light rain, all through the night, but no thunder. The 25th to 28th October were dull days, with slight rain during the nights. These were our first rains here this wet season. The 29th was bright sunshine, few clouds, warm and with a strongish S.E. wind blowing across the lake. The weather was cool, probably by reason of the wind. The flight of the butterflies was from due north by the compass to due south. When first noticed, the insects were passing at the rate of about 100—roughly—to the minute, in batches and singly. The line of flight through certain trees and back and front of my house was invariably adhered to. The width of the frontage of the flight was about 30 yards in all. I did not see butterflies outside this frontage. The wind, though strong, did not seem in any way to affect the line of flight. Occasionally butterflies would settle for brief moments on trees and flowers—the trees also being in flower, but they quickly passed on again. Always the trees, etc., were in the direct line of flight. The insects themselves were of two kinds, of which I send you herewith specimens. The nucleus of the flight consisted of the white butterflies, the proportion of the brown kind being probably about 1 in 50 or even less. All insects flew very strongly.

"Toward the end of the afternoon of the 29th the numbers became appreciably less—until about 4.30 p.m. the flight seemed to have finished. On the 30th inst., at about 8.30 a.m., the flight began again from the same direction to the same direction, along the original route. Insects at first were not too numerous, but towards midday large numbers were again passing, and as I write the flight continues.

"The weather to-day is hot and clear, and the wind, in the same direction as yesterday, is perhaps stronger if anything. The average height of insects above the ground would seem to be about 5 feet; very few really flying much higher than this, except when passing directly over trees. The flight to-day finished at 1.30 p.m., having gradually tapered off in numbers. I might mention that from about 12 noon to-day the numbers must have been decreased to less than 50 a minute."

The specimens sent by Mr. Mee were five males and two females of *Catopsilia florella*, all of the pale form, and two *Atella phalantha*.

(20) *Pieris helica* in Griqualand, S.A.

According to Mr. H. K. Munro, on the 15th December, 1926, Mr. C. J. Laird of Matatiele, Griqualand, Cape Province, S.A., wrote: "I am sending you by to-day's post some butterflies that are passing and settling in this district, there seem to be millions of them." The species was identified as *Pieris helica*.

(21) *B. mesentina* in Swaziland in 1927.

According to Mr. H. K. Munro of the Department of Agriculture of the Union of South Africa, the Principal Veterinary Officer of Mbabana, Swaziland, wrote that a swarm of millions of *Belenois mesentina* passed over that place in a north-easterly direction on the 19th January, 1927.

(22) *B. mesentina* (?) in S.E. Transvaal.

According to Mr. H. K. Munro, Mrs. S. M. Nicholson of Ermelo (S.E. Transvaal) wrote to the Department of Entomology that "On Saturday, 18th December, 1926, I noticed many little white butterflies drifting past." They continued on the following two days, and altogether millions drifted past. The direction of flight was not given.

Mr. Lounsbury, the Chief Entomologist, replied that the butterfly was assumed to be *Belenois mesentina*, of which several records had recently reached him.

(23) White Butterflies in Zululand in May 1905.

Mr. W. E. Jones, F.E.S., kindly sends me the following record:—

"In May 1905, whilst trekking with pack animals through the (then) big game reserve between the White and Black Umvolosi Rivers, Zululand, a similar swarm [to that noted below in Cape Province] was encountered early in the day. We passed through it at right angles, though how long it started before we struck it, and how long afterwards it continued I cannot state. Our pack animals were inclined to stampede, and the creatures hardly attempted to evade us, forging blindly ahead. It was a very thick swarm and a very wide one, making from west to east towards the ocean, distant about 15 miles. It would, before reaching the ocean, have had to cross St. Lucia Lake."

(24) White Butterflies in Cape Province, Union of South Africa.

Mr. W. E. Jones, F.E.S., kindly supplies me with the following record:—

"In January or February 1887 I saw a flight of 'cabbage whites' in the Gamtoos River Valley, District Humansdorp, Cape Province. They were making for the sea, distant by flight about ten miles, about midday, coming from a northerly direction. I sent a native servant to note the width of the swarm, which at its thickest measured over 130 yards, but there were stragglers on either side. The swarm took about three hours to pass my house, flying with the wind, which was brisk. It appeared to me to be very thick and was the first flight I had seen."

Humansdorp is a little west of Port Elizabeth, and the flight resembles those described by Bowker and Trimen, which consisted mainly of various species of *Belenois*.

(25) **White Butterflies in Zululand in February 1928.**

Mr. W. E. Jones also sends me the following note :—

“ I have authentically learnt of a flight of ‘ White butterflies ’ which passed from west to east in front of the court house Nkhandhla, Zululand, in February of this year [1928]. The swarm was not dense and about 200 yards wide, but sufficiently conspicuous to attract universal attention in the village. It continued for two days; species unknown. This information is given me by the assistant magistrate, Mr. Deane, and confirmed by the magistrate, Mr. Guy Arbuthnot, and others. The direction of the flight would again be towards the ocean. The magistrate told his native police to try and ascertain where the swarm had come from and where it was going. Fruitless ! ”

This is probably a species of *Belenois*.

(26) ***Terias desjardinsi* off the West Coast of Africa.**

Mr. G. Van Son, Assistant Entomologist at the Transvaal Museum, informs me that in October 1923, when sailing to South Africa, he observed and captured a number of perfect specimens of *Terias desjardinsi*, Bdv., which were attracted by the lights on the deck about 9 p.m. one evening. The nearest coast, which was Cape Verde, lay about 150 miles distant. The weather was calm for several days.

(27) **White Butterflies off Cape Verde Islands.**

Mr. V. A. Beckley, Chemist to the Department of Agriculture of Kenya, gives me the following notes :—

(1) In September 1914 he noticed small white butterflies flying westwards the whole day that they were at sea in the neighbourhood of Cape Verde. So far as he recollects it was a very calm day.

(2) In December 1920 he again observed insects off Cape Verde. The day was very calm, there was no breeze and the flight was steadily westward. The dominating insects were white butterflies, Pierids, he believes. He saw a few others, but not close enough to recognise them. There were also a few dragonflies and a few grasshoppers in the flight. They were noticed the whole day long, but at no time was the flight at all dense. It was continuous but scattered.

(28) **Migration of *Lampides boeticus* in the United Provinces in India in March 1928.**

Mr. T. D. Broughton, F.E.S., kindly sends me the following information :—

“ There is an annual migration of *Lampides boeticus* in the Kumaon Hills in March. I have noticed it for several years.

“ Nainital is an enclosed valley with a lake about a mile long at the bottom running roughly from south-east to north-west. The level of the lake is just over 6000 feet, and the peaks around rise to an elevation of rather over 8000 feet.

“ In 1928 I first noticed *L. boeticus* on Saturday, March 17th.

“ Monday, 19th, was fine with a high, cold wind. I noticed many *L. boeticus* flying into the valley through the gap at the lower end against the strong wind which was blowing down the valley. There were also a few *Colias fieldi* in flight.

“ The flight went on for several days, and must have numbered many thousands. *L. boeticus* is not very conspicuous, but several people asked what the small blue butterfly was that had suddenly appeared.

"I left Naini on 26th on tour and on 30th and 31st I noticed many *L. boeticus* at Lansdowne, a hill station in Garwhal, north-west of Nainital. These were not on migration.

"Many of these butterflies remain in Naini. They are mostly in good condition when they arrive. They disappear about the middle of May, and are succeeded later in the year by smaller numbers of later broods which are no doubt locally bred. The climate of Naini in the winter is cold with sun and frost.

"The flight was going on at the head of the valley, and many butterflies must have passed out of it, though many remained. There are no high ranges for some eighty miles to the north, the country being very broken with valleys and ridges, but nothing much over 8000 feet."

(29) **Migration of the Hesperid *Achalarus bifasciatus casyapa* (M.) at Mussoorie, India.**

Mr. O. C. Ollenbach kindly gives me the following record :—

"During the latter half of September 1918 large numbers of the above were to be seen flying from north to south, at Mussoorie, a station on the outer range of the N.W. Himalaya, elevation about 6000 feet, in the United Provinces of India. The flight began late in the afternoons and continued till a little after dark. The insects appeared to come from the valley to the north of this range, and crossing it at the gaps and saddles, descended into the valleys to the south which border the valley of the Dun. The rate of flight was very great, and the switch of their wings was distinctly audible. This flight lasted 14 days, the wind being from south to north. This evidently was a local migration, as I did not observe any of these Skippers in the Dehra Dun Valley, which lies some eight miles to the south. The weather was bright at times and misty at other times and decidedly cool."

(30) **Migration of *Kallima inachus hügelii* (Koll.) at Dehra Dun, U.P., India.**

Mr. O. C. Ollenbach kindly gives me the following record :—

"An annual migration from north to south during October and November. During November 1924 the numbers were quite considerable and stretched across the valley of the Dehra Dun, which is some 40 miles wide. In most cases the specimens taken are perfect and fresh. This evidently is a local migration, as the insects do not appear to cross the Siwalik Range, which shuts in the Dehra Dun Valley on the south. Dehra Dun is situated in the United Provinces of India, at the foot of the N.W. Himalayas : elevation 2200 feet."

(31) **Migration of *Lampides boeticus* (L.) at Dehra Dun, U.P., India.**

Mr. O. C. Ollenbach kindly gives me the following record :—

"This is an annual migration, and I have observed it for over twenty years. The direction is always the same, S.E. to N.W., and the wind at this time of the year is always from S.W. to N.E., or at about right angles to the line of migration. The numbers have varied considerably in different years, as is to be expected. The period of migration generally lasts a month or more, from middle of April to end of May. This year [1928] I observed it from middle April to 20th May, after which date I left the station. This was also the greatest migration I have ever seen, as the insects flew past in myriads, all flying at a great pace and flying low at about 3 to 5 feet from the ground. During most

of this period the weather was clear and hot. The locality where these migrations occur is Dehra Dun in the United Provinces of India, and is at the foot of the N.W. Himalaya Mountains."

(32) **Migration of Catopsilias at Dehra Dun, U.P., India.**

Mr. O. C. Ollenbach kindly gives me the following record :—

"*C. crocale* (Cr.) and *C. pyranthe* (Herbst) migrate annually, and the flight takes place in the latter half of June and the first half of July, just about the time the monsoon reaches this region. These flights are never dense, and they may be said to fly past in hundreds. The direction of most of the flights observed by me was from east to west, but I have known them to fly from west to east. The wind at this season is S.W. to N.E., and the weather rather wet with periods of bright sunshine; it is also very warm. The insects fly only during sunshine and settle immediately the sun is obscured, resuming their flight when the sun comes out again. These flights occur annually at Dehra Dun in the United Provinces of India, and have been observed by me for very many years."

(33) **Migration of DANAINAE at Tavoy, Burma, in January 1920.**

Mr. O. C. Ollenbach kindly gives me the following record :—

"The following species took part in this flight;

Danaïs melisa septentrionis (Butler).

Euploea modesta (Butler).

Euploea crameri bremeri (Flder.).

Euploea deione menetriesi (Flder.).

Euploea mulciber (Cramer).

Euploea midamus brahma (Moore).

Euploea klugii crassa (Butler).

The insects were in vast numbers and the direction was from N.E. to S.W., the wind being from S.W. to N.E. This flight lasted for six days, 20th to 25th January, 1920, after which latter date I left the district, and so am unable to say how much longer it continued. The flight was at least 10 miles wide to my knowledge, but was probably considerable wider. The insects appeared to have travelled for days, as their flight was slow and laboured and they were without exception in poor condition, being much torn and rubbed. Towards sunset they settled on bushes and small trees, and resumed their flight about 9 a.m. the next morning. The place where I came across this migration was some eleven miles from the sea, and they were flying straight for it. It may be that they crossed over to the numerous islands which form the Mergui Archipelago. For a few days I collected specimens largely so as to identify the species which took part in the migration, and the names given above are correct. The weather at the time of and previous to the flight was bright and distinctly warm.

"Tavoy is a district of Southern Burma and borders on Siam and Mergui."

(34) **Flight of *Crastia core* in India.**

Brig.-General J. B. Tulloch kindly gives me the following record :—

In July 1922, when at Deolali in Bombay Province, India, he saw a "continuous dribble" of *Crastia core* passing diagonally across the wind (south-west monsoon well set in). The flight of butterflies was normal, but out in the open

instead of near woods and undergrowth. Two or three were passing per minute, and the flight went on for several days during the "wet weather hatch out" of this particular butterfly. The flight was to the east across the south-west winds.

(35) **Flight of various Butterflies at Pachmari, Central Province.**

Brig.-General J. B. Tulloch gives me the following record :—

At Pachmari in the Mahadeo Hills, Central Province, India, in September 1922, when the monsoon (south-west) was dying out with daily thunderstorms and wind variable and between the storms very clear and hot, he was collecting in the open grass golf links between the surrounding jungle and noticed that all classes of butterflies were drifting lazily diagonally across the wind, and nearly always in one direction. He is unable to give the exact direction of wind and flight, but sends me a diagram showing the flight with the wind behind it, but at an angle of about forty-five degrees.

In a later letter Genl. Tulloch adds : "The insects moving diagonally across the wind at Pachmari were what I call restless or wandering butterflies such as *Catopsilia crocale*, *C. pyranthe*, *Delias eucharis*, *Pyrameis cardui*, *Terias hecabe*, and some others as some species of *Euploea* and one or two unidentified *Papilios*. Things like *lethe*, *ypthima*, *Precis iphita*, etc., which keep to woods were not represented."

(36) **Migration of White Butterflies in Florida in April 1906.**

I am indebted to Dr. Percy R. Lowe of the British Museum (Natural History) for the following record. The record was made on the west coast of Florida during a cruise of S.Y. "Zanaida" and written down at the time.

"On April 28th and 29th, 1906, I noticed an extraordinary flight of white butterflies which took place across Boca Grande Pass while we were fishing for tarpon. Each morning they came in a steady stream of many hundreds and thousands across the Pass from the south end of Gasparilla Island to the north end of the Costa. The flight lasted about two hours each morning, from about 9 a.m. till 11 a.m. The direction the butterflies took was practically due south. The wind was south-easterly. The butterflies were of both sexes and looked very much like our common white butterfly in England. There are not any more flowers and there is no difference in vegetation on Cas La Costa, so it is difficult to understand why they were all so determinedly migrating. The flight was at its greatest on the 28th and 29th, but for a few days afterwards many hundreds struggled across. It is possible they may have been migrating further south along the chain of islands which run along the west coast of Florida hereabouts, and so may have passed right over Gasparilla before reaching the Pass."

It is almost certain that the species concerned was *Pieris monuste*, as this has already on at least four previous occasions been recorded as migrating in Florida. Three of these, one in April 1884, one in early June 1908, and a third in early June 1923, were all to the south. A fourth record before 1899, without exact date, was said to be to the north.

(37) ***Eunice modesta* in British Honduras.**

Mr. F. L. Davis gives me the two following records, unfortunately, however, without the exact date :—

(1) "At another time when I was stationed at Corozal in the north of the Colony [British Honduras] all the houses in the town were invaded by vast

numbers of the small brown butterfly *Eunice modesta* (Bates). These must have reached the town after the electric lights had been lighted, and were attracted into the rooms by the bright lights. I myself collected in my own rooms as many, both males and females, as I required."

(2) "Once when I was in the Orange Walk District, which is also in the north of the Colony and about 35 miles from Corozal, I witnessed a flight of this same small butterfly, but that was in the afternoon. They came in hundreds and thousands and as far as I can remember the flight lasted for an hour or two. I remember that on this latter occasion they came along from the north. This particular butterfly I have hardly ever seen in British Honduras, but I learn that it is common in Mexico, so it must be that these flights were helped on by the prevailing N.E. winds."

(38) *E. modesta* in Costa Rica about 1912.

Mr. C. H. Lancaster writes to me that "About 1912 there was a noticeable migration of *Eunice modesta*, thousands of them all day from 10 o'clock on. I was then in Cachi, and they flew from N.W. to S.E. also, like URANIDAE. My specimens would give the exact date as none have appeared since."

(39) *Papilio philolaus* in British Honduras.

Mr. F. L. Davis writes to me [in 1928]: "Once I saw at Corozal what might almost be called a flight (for they were in great numbers all flying in the same direction) of *Papilio philolaus*, Bois. These were flying over the town of Corozal, mostly in a steady way, but a few resting here and there on the ground."

(40) *Gonepteryx macrula* in British Honduras.

Mr. F. L. Davis, writing on 9th July, 1928, says: "Some years ago in the month of August I witnessed a flight of *Gonepteryx macrula* at a little village on the seashore a few miles from Belize. The flight lasted about three hours, and the butterflies were exceedingly numerous. The day was bright, sunny and hot, and the time from about 11 a.m. to 2 p.m. They flew with the prevailing wind, which was N.E., and showed no disposition to settle or rest."

(41) Migrant Butterflies in Australia.

Mr. E. Jarvis of Cairns, Queensland, gives me the following notes on migratory insects in Australia:—

"Those species that I have noticed during my stay in Australia (a period of 41 years) as displaying migratory habits are as follows:—

"*Danaïs affinis*, *Danaïs petilia*, *Belenois java*, *Badamia exclamatoris*, *Acraea andromacha*, *Terias similax* and *Nyctalemon orontes*.

"There are probably other species of butterflies which occasionally occur gregariously at certain times of the year. *Callidryas pomona* and *crocale*, for instance, but these may not migrate to any distance.

"In Victoria I observed on more than one occasion the migration of *B. java* from New South Wales into the southern portions of Victoria. These insects flew in countless numbers across the Dandenong ranges of Victoria [east of Melbourne] to the sea coast between Geelong and Cape Howe, taking about a couple of weeks to pass through Emerald [about 20 miles east-south-east of Melbourne], where I was stopping. During this flight dozens were seen passing, one each minute of the day when the sun was shining.

"After about three weeks or less they were seen to be returning, all flying in the opposite direction towards Sydney [*i.e.* to N.E.—C.B.W.].

"This species, I believe, breeds somewhere near Central New South Wales. the caterpillars feeding on plants belonging to the Capparideae. I have never found the larva of this butterfly in Victoria.

"During May and June last [1928] in the Cairns district of Queensland I noticed vast numbers of *Acraea andromacha* passing through, but this species, so far as I am aware, does not breed here, although I have found the caterpillar feeding on a small species of *Aristolochia* in the suburbs of Brisbane.

"At Toowong, a few miles from Brisbane, I have often noticed this butterfly laying eggs on the common passion-fruit vine, but although these eggs hatched the larvae refused to feed on this plant. Similarly, near Cairns in Queensland, scores of these butterflies, while passing through the district, settled on the leaves of our granadillas, laying countless thousands of eggs on the leaves, which however, produced larvae that would not eat these leaves, and all died without causing any damage.

"*Danaus affinis* I once noticed at Tweed Heads, near Brisbane, settled in myriads on the trees and shrubs about half a mile from the sea coast. One could have caught dozens if desired at every sweep of the net, and most of the specimens were in good condition, and did not appear to have come very far. This assumption, however, might easily be a mistake, seeing that the *Danaidas* do not fly very rapidly and might travel for several days without getting noticeably rubbed or torn."

(42) *Badamia exclamationis* in Queensland.

Through the kindness of Mr. G. A. Waterhouse I am able to quote the following extract from a letter written to him by Mr. C. M. Kensal of Deeral, near Cairns, Queensland, on 10th May, 1919.

"I am much interested in the fighting habits of *Badamia exclamationis*, and I notice that you refer briefly to 'great flights of this butterfly' which 'have on several occasions been noticed in Queensland.' But, unlike occasional Pierid flights which I have witnessed, these flights are all regular seasonal ones occurring twice if not three times every year, in December and March and I think also in October.

"These flights last from one to two weeks with varying intensity according to the weather, and always in the same direction and extending over a wide area. I have taken notes during these flights, and I find that an average of 24,000 Skippers pass over every 100 yards every hour. I have ridden over a great part of this long valley during one of these flights, and the swarm of passing Skippers was continuous throughout. . . .

"Where I am living is a long valley running from Cairns (which is 27 miles away) southward. The Skippers cross the valley obliquely from the S.W. to N.E. I have never seen them flying in a contrary direction, and it is very seldom that they stop or loiter on their path. . . . In the direction from which they come are the Bellenden-Kei Ranges, and in the direction of their flight the coast ranges which is almost as impenetrable and jungle-covered to the summit.

"I have seen these Skippers feeding on Bloodwood blossom [most probably a species of *Eucalyptus*, G.A.W.] in immense numbers."

Amani, Tanganyika.

Dec. 1928.

A SYNONYMIC LIST OF DRAGONFLIES OF THE FAMILY GOMPHIDAE (ODONATA, ANISOPTERA) FOUND IN THE ORIENTAL REGION

By F. F. LAIDLAW, M.A.

[Read June 4th, 1930.]

I. INTRODUCTION.

II. REFERENCES TO LITERATURE.

III. LIST, WITH SYNONYMS AND NOTES.

I. INTRODUCTION.

Scope of List.

The list is intended to include all GOMPHIDAE recorded from the Oriental Region. For the present purpose I define the limits of the Region as follows:—

To the North, the latitude of Shanghai (about 31' N.), excluding any part of Japan. To the West, the political frontier of British India. To the South and East, the Oriental GOMPHIDAE have settled the matter for themselves; they do not appear to have extended their range beyond "Wallace's line," save for one or two species found in Celebes. These limits are admitted to be arbitrary.

Arrangement.

References to species in the text of the list are given by the name of the writer of the paper referred to, followed by the date. This method of reference is convenient and economises space.

References to papers are given in full, as far as possible in order of date of publication, under the heading "literature."

Reference to a paper in which a species is listed entirely without comment is marked with an asterisk (*).

Genera, or generic names, proposed after the date of publication of Kirby's Catalogue are also given appropriate reference.

Where an author is responsible for the publication of more than one paper in a given year the second and subsequent references in that year are distinguished by the letters *a*, *b*, *c*, etc., placed after the date.

Species which I have been able to examine personally are marked with a (†).

Species whose generic position is doubtful have a query mark put after the generic name. These are not numbered.

The locality or localities from which a species is recorded is printed beside its definitive specific name. Where I feel doubt as to the accuracy of a recorded area, I have put the name of that area in italics.

Geographical races are numbered as species, but no number is given in the case of species as to whose validity considerable doubt exists.

Reference is not made to publications which appeared before the compilation of Kirby's Catalogue.

In a few cases I have added in brackets () a short note after a species, where I have thought such a note will serve to clear up any ambiguity.

Short notes are added also after certain genera, in cases where some explanation of nomenclature, or other matter, seemed to me to be called for.

I have used the Selysian generic names where these are available; the genera were defined by de Selys and the names are familiar to Odonatologists, and have moreover been used by Ris, Williamson and other writers in systematic papers of importance.

The list gives numbers for 160 species, a number in excess of any other of the Anisopterous families in the Oriental Region, and indicating the great wealth of this Region in GOMPHIDÆ. At the same time it suggests that within limits the family is a modern and successful branch of the Order, though the habits and life-histories of its members do not tend to bring it into prominence.

It is necessary to give a few comments on the classification followed here. The "series" are those defined by Williamson (Williamson, 1920).

Of these "*Hagenius*" and "*Diastatomma*" are very natural groups; they may come to have the rank of subfamilies. The two others represented in our fauna, "*Epigomphus*" and "*Gomphus*," are not so easily separated from each other. The genera included in *Gomphus* appear to be more specialised, in regard to venation at any rate, than do those grouped under *Epigomphus*, and I am inclined to believe that the Gomphine genera have been derived from Epigomphine stock, though probably not from a single Epigomphine ancestral form. It is indeed quite likely that genera both of the *Epigomphus* and of the *Gomphus* series in certain cases have come to resemble one another as the result of convergence rather than because of close relationship.

Amongst the *Epigomphus* series the genus *Leptogomphus* appears to me to be related somewhat closely to the S. American genus *Epigomphus*. *Helio-gomphus* and *Microgomphus* are certainly nearly allied *inter se*, whilst *Macro-gomphus*, perhaps the most distinctive Oriental genus of the family, seems to stand alone.

Turning to the series *Gomphus*, I have brigaded the genera here assigned to it in "*alliances*." These depend in part on similarity between the anal appendages of the males and in part, especially in the case of the *Cyclogomphus* alliance, on the length and armature of the femora. The genus *Perissogomphus* seems to me to be a primitive form allied to *Gomphus* (sens. str.), but retaining in the venation evidences of a lower grade of specialisation. *Acrogomphus* is possibly intermediate between the *Onychogomphus* and the *Heterogomphus* alliances, and more primitive than either. The position of *Ophiogomphus* and of *Davidius* is at present obscure.

The alliances I suggest must be regarded as representing only my present view on the relationship of genera. Much work, on the larval characters, on the venation, and on other structural features, is required before any really satisfactory phylogenetic grouping of these series can be made. It is in the hope that this list will facilitate further work that it has been drawn up.

I lastly must acknowledge my indebtedness to Col. F. C. Fraser, I.M.S., not only for generous supplies of material but also for useful suggestions, corrections and advice in drawing up this list.

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III. LIST OF SPECIES WITH SYNONYMS AND NOTES.

Series HAGENIUS.

Genus *Sieboldius*, Selys.

Genotype *S. japonicus*, Selys.

Range of genus : China, Japan, Indo-China, Borneo, Sumatra, Malaya.

1. †*S. japonicus*, Selys. Malay Peninsula, Borneo, Sumatra.

Sieboldius japonicus, Kirby, 1890.

Williamson, 1907.

Laidlaw, 1914.

id., 1922.

Fraser, 1927.

Lieftinck, 1929a (larva).

Sieboldius japonicus, Förster, 1914.
 Laidlaw, 1914.*
Sieboldius grandis, Kruger, 1898.
 Laidlaw, 1902.

2. **S. gigas** (Martin). Tonkin.
Hagenius gigas, Martin, 1904.
 Fraser, 1924*d*.
Sieboldius gigas, Fraser, 1927.
3. **S. nigricolor** (Fraser). S. Shan States.
Hagenius nigricolor, Fraser, 1924*d*.
Sieboldius nigricolor, id., 1927.

Series DIASTATOMMA.

Genus **Ictinus**, Ramb.
 Genotype *I. rapax* (Ramb.).

Range of genus: Tropical Africa, Tropical Asia to Japan, Papua and Tropical Australia.

1. †**I. rapax** (Ramb.). India, *Indo-China*.
Ictinus rapax, Kirby, 1890.
 Martin, 1904.*
 Williamson, 1907.
 Fraser, 1921.*
 Laidlaw, 1922.
 id., 1924.
Ictinus rapax rapax, Fraser, 1923*a*.
 id., 1923*b*.
 id., 1923*c*.
 id., 1924.
Ictinus praecox, Kirby, 1890.
 Williamson, 1907.
 Laidlaw, 1922.
Ictinus rapax praecox, Fraser, 1923*a*.
 id., 1923*b*.
 id., 1923*c*.
 id., 1924.
Ictinus mordax, Kirby, 1890.
 Williamson, 1907.
 Laidlaw, 1922.
Ictinus rapax mordax, Fraser, 1923*a*.
 id., 1923*b*.
 id., 1923*c*.
 id., 1924.
2. **I. fallax**, Selys. Formosa.
Ictinus fallax, Kirby, 1890.
 Williamson, 1907.
 Oguma, 1926.
3. †**I. tenax**, Selys. Philippine Is.
Ictinus tenax, Kirby, 1890.
 Williamson, 1907.

4. †**I. angulosus**, Selys. India.
Ictinus angulosus, Kirby, 1890.
 Williamson, 1907.
 Laidlaw, 1922.
 Fraser, 1923*a*.
 id., 1923*b*.
 id., 1923*c*.
5. **I. atrox**, Selys. India.
Ictinus atrox, Kirby, 1890.
 Williamson, 1907.
 Laidlaw, 1922.
 Fraser, 1923*a*.
 id., 1923*b*.
 id., 1923*c*.
6. **I. pertinax**, Selys. China, Tonkin.
Ictinus pertinax, Kirby, 1890.
 Martin, 1904.*
 Williamson, 1907.
 Ris, 1916.
 Fraser, 1923*a*.
 id., 1923*b*.
 id., 1923*c*.
7. **I. decoratus**, Selys. Java, Sumatra, Tonkin, Borneo.
Ictinus decoratus, Selys, 1899.
 Kirby, 1890.
 Kruger, 1898.
 Martin, 1904.*
 Williamson, 1907.
 Laidlaw, 1914.
 id., 1920.*
 Fraser, 1926.
8. †**I. melaenops**, Selys. Malaya, Sumatra, Borneo, Tonkin.
Ictinus melaenops, Kirby, 1890.
 Karsch, 1891.
 Williamson, 1907.
 Ris, 1911.
 Laidlaw, 1914.
 id., 1920.*
 Ris, 1927.
Ictinus melanops, Laidlaw, 1902.*
 Martin, 1904.*
Ictinus melaenops v. *sumatranus*, Kruger, 1898.
9. **I. clavatus** (Fabr.). Japan, China, Tonkin.
Ictinus clavatus, Kirby, 1890.
 Martin, 1904.
 Williamson, 1907.
 Oguma, 1926.
10. **I. phaleratus**, Selys. China, Tonkin.
Ictinus phaleratus, Kirby, 1890.
 Martin, 1904.
 Williamson, 1907.

11. †**I. acutus**, Laidlaw. Borneo.
Ictinus acutus, Laidlaw, 1914.
 id., 1920.*

Genus **Gomphidia**, Selys.
 Genotype *G. t-nigrum*, Selys.

Range of genus Oriental (except Ceylon?).

1. †**G. t-nigrum**, Selys. S.W. India.
Gomphidia t-nigrum, Kirby, 1890.
 Williamson, 1907.
 Laidlaw, 1922.
 Fraser, 1923a.
 id., 1923b.
 id., 1923c.
 id., 1924.
 Ris, 1927.
2. †**G. maclachlani**, Selys. Borneo, *Tonkin*.
Gomphidia maclachlani, Kirby, 1890.
 Kruger, 1898.
 Martin, 1904.*
 Williamson, 1907.
 Laidlaw, 1914.
 id., 1920.*
 Ris, 1927.
3. †**G. kirschi**, Selys. Philippine Is.
Gomphidia kirschi, Kirby, 1890.
 Martin, 1904.
 Williamson, 1907.
 Laidlaw, 1914.
Gomphidia karschi, [sic.] Laidlaw, 1920.*
4. **G. confluens**, Selys. China, Tonkin, Formosa.
Gomphidia confluens, Kirby, 1890.
 Martin, 1904.
 Williamson, 1907.
 Ris, 1916.
5. **G. javanica**, Förster. Java.
Gomphidia javanica, Förster, 1899.
 Williamson, 1907.
 Fraser, 1926.
6. †**G. perakensis**, Laidlaw. Malaya.
Gomphidia perakensis, Laidlaw, 1902.
 Williamson, 1907.
7. †**G. krugeri**, Martin. Tonkin.
Gomphidia krugeri, Martin, 1904.
 Williamson, 1907.
8. **G. abbotti**, Williamson. Burma.
Gomphidia abbotti, Williamson, 1907.
 Fraser, 1923a.
 id., 1923b.
 id., 1923c.
 Ris, 1927.

9. †**G. kodaguensis**, Fraser. Coorg, S. India.
Gomphidia kodaguensis, Fraser, 1923c.
 id., 1924.

10. **G. fletcheri**, Fraser. Coorg, S. India.
Gomphidia fletcheri, Fraser, 1923c.
 id., 1924.

11. **G. williamsoni**, Fraser. Bengal.
Gomphidia williamsoni, Fraser, 1923c.

12. **G. caesarea**, Lieftinck. Borneo.
Gomphidia caesarea, Lieftinck, 1929.

Series EPIGOMPHUS.

Genus **Leptogomphus**, Selys (restr.).

See Ris, 1914.

Laidlaw, 1922.

Genotype *L. semperi*, Selys.

Range of genus Oriental excluding S. India, and Ceylon.

1. **L. semperi**, Selys. Burma, Tonkin, Borneo.
Leptogomphus semperi, Kirby, 1890.

Martin, 1904.*

Williamson, 1907.

Ris, 1912.

Laidlaw, 1914.

id., 1920.*

id., 1922.*

Fraser, 1927.

2. **L. inclitus**, Selys. Burma.
Leptogomphus inclitus, Kirby, 1890.

Williamson, 1907.

Laidlaw, 1922.

Fraser, 1923a.

id., 1923b.

id., 1927.

3. **L. lansbergei lansbergei**, Selys. Java.
Leptogomphus? lansbergei, Kirby, 1890.

Leptogomphus lansbergei, Kruger, 1893.

Williamson, 1907.

Ris, 1914.

id., 1927.

Fraser, 1926.

id., 1927.

? *Malayogomphus semiteres*, Förster, 1914.

4. †**L. lansbergei assimilis**, Kruger. Sumatra, Mentawi Is.
Leptogomphus assimilis, Kruger, 1893.

Williamson, 1907.

Leptogomphus lansbergei, Laidlaw, 1926.

Leptogomphus lansbergei assimilis, Ris, 1927.

5. **L. gestroi**, Selys. Burma, Tonkin.
Leptogomphus gestroi, Selys, 1891.
 Martin, 1904.*
 Williamson, 1907.
 Laidlaw, 1922.
 Fraser, 1923a.
 id., 1923b.
 Fraser, 1927.
6. **L. sauteri**, Ris. Formosa.
Leptogomphus sauteri, Ris, 1912a.
 id., 1916.
 Fraser, 1927.
Leptogomphus formosanus, Oguma, 1926.
7. **L. yayeyamensis**, Oguma. Riu-Kiu Is.
Leptogomphus yayeyamensis, Oguma, 1926.
8. **L. perforatus**, Ris. S. China.
Leptogomphus perforatus, Ris, 1912a.
9. †**L. williamsoni**, Laidlaw. Borneo.
Leptogomphus williamsoni, Laidlaw, 1912.
 id., 1914.
 id., 1920.*
- L.? maculivertex**, Selys. Burma.
Leptogomphus? maculivertex, Selys, 1891.
 Williamson, 1907.
 Laidlaw, 1922.
 Fraser, 1923a.
 id., 1923b.
 id., 1927.
- L.? parvus**, Kruger. Sumatra.
Leptogomphus? parvus, Kruger, 1898.
 Williamson, 1907.
 Fraser, 1927.

(Fraser suggests (in litt.) that this species is perhaps a small *Burmagomphus*.)

Genus **Heliogomphus**, Laidlaw, 1922.

Genotype *H. selysi* (Fraser).

Range of genus : S. India, Ceylon, Assam, Burma, Indo-China, Malaysia, Philippines.

1. †**H. selysi** (Fraser). Assam.
Leptogomphus nietneri (pars), Selys, 1891.
 Martin, 1904.*
Leptogomphus? nietneri, Williamson, 1907.
Heliogomphus nietneri (pars), Laidlaw, 1922.
 id., 1925.
Heliogomphus selysi, Fraser, 1925b.

2. †**H. promelas** (Selys). Western Ghats of India, Palnai and Annamallai Hills.
Aeshna promelas, Kirby, 1890.
Gomphus ? *promelas*, Williamson, 1907.
 Laidlaw, 1922.*
Gomphus promelas, Fraser, 1923a.
 id., 1923b.
Heliogomphus pruinans, Fraser, 1922.
 id., 1923a.
 id., 1923b.
Heliogomphus promelas, Fraser, 1925b.
3. **H. nietneri** (Selys). Ceylon.
Anisogomphus nietneri, Kirby, 1890.
 id., 1893.
Leptogomphus nietneri (pars), Selys, 1891.
Leptogomphus ? *nietneri*, Williamson, 1907.
 Ris, 1912a.
Heliogomphus nietneri (pars), Fraser, 1922.
 id., 1923a.
 id., 1923b.
 id., 1925b.
 Laidlaw, 1924.
Aeshna ? *ceylonica*, Kirby, 1890.
Aeshna ceylonica, Kirby, 1893.*
Gomphus ? *ceylonicus*, Williamson, 1907.
 Laidlaw, 1922.
Gomphus ceylonicus, Fraser, 1923a.
 id., 1923b.
Heliogomphus ceylonicus, Fraser, 1925b.
4. **H. gracilis** (Kruger). Sumatra.
 ? *Leptogomphus gracilis*, Kruger, 1898.
Leptogomphus gracilis, Williamson, 1907.
Heliogomphus gracilis, Fraser, 1926.
 Ris, 1927.
5. †**H. kelantanensis** (Laidlaw). Malaya.
Gomphus consobrinus, Laidlaw, 1902.
Gomphus kelantanensis, Laidlaw, 1902a.
Leptogomphus kelantanensis, Williamson, 1907
 Laidlaw, 1914.
 id., 1922.*
 Fraser, 1927.*
Heliogomphus kelantanensis, Laidlaw, 1925.
6. **H. scorpio** (Ris). Kwan-Tung, China.
Leptogomphus scorpio, Ris, 1912.
Heliogomphus scorpio, Laidlaw,* 1925.
7. **H. retroflexus** (Ris). Tonkin.
Leptogomphus retroflexus, Ris, 1912.
Heliogomphus retroflexus, Laidlaw, 1925.*

8. †**H. spirillus** (Fraser). Shillong.
Leptogomphus spirillus, Fraser, 1922.
Heliogomphus spirillus, Fraser, 1923a.
 id., 1923b.
9. †**H. bakeri**, Laidlaw. Philippine Is.
Heliogomphus bakeri, Laidlaw, 1925.
10. **H. walli**, Fraser. Ceylon.
Heliogomphus walli, Fraser, 1925b.
11. **H. blandulus**, Lieftinck. Borneo.
Heliogomphus blandulus, Lieftinck, 1929.
12. †**H. drescheri**, Lieftinck. Java.
Heliogomphus drescheri, Lieftinck, 1929.

When characterising the genus, I had before me examples from the Garo Hills, Assam, which I believed at the time to be referable to *nietneri*. Specimens from the same district were subsequently distinguished by Fraser as a distinct species *selysi* which therefore becomes the type of the genus.

Genus **Microgomphus**, Selys.

Genotype *M. chelifer*, Selys.

Range of genus : S. India, Burma, Malaysia.

1. †**M. chelifer**, Selys. Malaya, Borneo, Sumatra.
Microgomphus chelifer, Kirby, 1890.
 Kruger, 1898.
 Laidlaw, 1902.*
 Williamson, 1907.
 Laidlaw, 1914.
 id., 1920.*
 Lieftinck, 1929.
2. †**M. torquatus** (Selys). W. Deccan.
Cyclogomphus torquatus, Kirby, 1890.
 Williamson, 1907.
Microgomphus torquatus torquatus, Fraser, 1924.
Microgomphus torquatus, Laidlaw, 1922.
 Fraser, 1923a.
 id., 1923b.
 id., 1925.
3. †**M. souteri**, Fraser. S. India.
Microgomphus torquatus souteri, Fraser, 1924.
Microgomphus souteri, Fraser, 1925.
4. **M. loogali**, Fraser. N. Shan States.
Microgomphus burmicus, Fraser, 1925.
Microgomphus loogali, Fraser, 1923a.
 id., 1923b.
5. **M. lilliputians**, Fraser. Tenasserim.
Microgomphus lilliputians, Fraser, 1923a.
 id., 1923b.
 id., 1925.

6. **M. thelyphonus**, Lieftinck. Java.

Macrogomphus thelyphonus, Lieftinck, 1929.

Genus **Macrogomphus**, Selys.

Genotype *M. robustus*, Selys.

Range of genus : S. India, Ceylon, Assam, Burma, Indo-China, Malaysia.

1. **M. robustus**, Selys. Nepaul ?

Macrogomphus robustus, Kirby, 1890.

Williamson, 1907.

Fraser, 1923*a*.

id., 1923*b*.

id., 1926*c*.

2. †**M. wynaadicus**, Fraser. Nilgiri Hills, Ceylon.

Macrogomphus wynaadicus, Fraser, 1924.

id., 1926*c*.

Macrogomphus annulatus (?), Laidlaw, 1924.

3. †**M. annulatus**, Selys. Deccan.

Macrogomphus annulatus, Kirby, 1890.

Martin, 1904.

Williamson, 1907.

Fraser, 1919 (larva).

Laidlaw, 1922.

Fraser, 1923*a*.

id., 1923*b*.

id., 1924.

id., 1926*c*.

4. †**M. montanus**, Selys. Sylhet.

Macrogomphus montanus, Kirby, 1890.

Williamson, 1907.

Laidlaw, 1922.

Fraser, 1923*a*.

id., 1923*b*.

id., 1924*d*.

id., 1925.

id., 1926*c*.

5. **M. parallelogramma** (Burm.). Java.

Macrogomphus parallelogramma, Selys, 1889.

Kirby, 1890.

Kruger, 1898.

Williamson, 1907.

Ris, 1912.

Fraser, 1926.

6. **M. quadratus**, Selys. Sumatra, Borneo.

Macrogomphus quadratus, Selys, 1899.

Kirby, 1890.

Kruger, 1898.

Williamson, 1907.

Laidlaw, 1914.

id., 1920.*

7. †**M. thoracicus**, Macl. Malaya.
Macrogomphus thoracicus, Kirby, 1890.
 Kruger, 1898.
 Laidlaw, 1902.
 Williamson, 1907.
Macrogomphus quadratus (♀), Förster, 1899.
8. †**M. albardae**, Selys. Sumatra, Malaya.
Macrogomphus albardae, Selys, 1899.
 Kirby, 1890.
 Karsch, 1891.*
 Kruger, 1898.
 Williamson, 1907.
 Ris, 1911.
 Laidlaw, 1914.
 id., 1920.*
9. †**M. decemlineatus**, Selys. Sumatra, Borneo.
Macrogomphus decemlineatus, Selys, 1899.
 Kirby, 1890.
 Kruger, 1898.
 Williamson, 1907.
 Laidlaw, 1914.
 id., 1920.*
10. **M. abnormis**, Selys. Borneo ?
Macrogomphus abnormis, Kirby, 1890.
 Williamson, 1907.
11. **M. rivularis**, Förster. Tonkin.
Macrogomphus rivularis, Förster, 1914.
 ? = *Macrogomphus sp.*, Williamson, 1907.
12. †**M. seductus**, Fraser. Assam.
Macrogomphus seductus, Fraser, 1926c.
Macrogomphus robustus, Laidlaw (nee Selys), 1922.

Series GOMPHUS.

Cyclogomphus alliance.Genus **Merogomphus**, Martin, 1904.

Williamson, 1907.

= *Indogomphus*, Fraser, 1922.Genotype *M. paviei*, Martin.

Range of genus : India, Indo-China, Malaya.

1. †**M. paviei**, Martin. Indo-China.
Merogomphus paviei, Martin, 1904.
 Williamson, 1907.
2. †**M. cerastes** (Selys). Nepaul, N. India.
Lindenia cerastis, Kirby, 1890.
Onychogomphus cerastis, Williamson, 1907.
 Laidlaw, 1922.
Onychogomphus cerastes, Fraser, 1923a.
 id., 1923b.
Indogomphus cerastes, Fraser, 1925.

3. †**M. longistigma** (Fraser). Western Ghats of India.

Indogomphus longistigma, Fraser, 1922.

id., 1923a.

id., 1923b.

id., 1924.

id., 1925.

4. †**M. martini** (Fraser). Duars, Bengal.

Platygomphus martini, Fraser, 1922.

id., 1923a.

id., 1923b.

Burmogomphus duarensis, Fraser, 1922a.

id., 1923a.

id., 1923b.

Indogomphus martini, Fraser, 1925.

†**M. sp.** Malaya.

Genus **Stylogomphus**, Fraser, 1922.

Genotype *S. inglisi*, Fraser.

Range of genus : Darjiling Distr.

1. †**S. inglisi**, Fraser. Darjiling Distr.

Stylogomphus inglisi, Fraser, 1922.

id., 1923a.

id., 1923b.

id., 1925.

Shows some relationship with *Merogomphus* I think. Fraser, however, does not believe that the genus is to be referred here.

Genus **Anisogomphus**, Selys.

Genotype *A. occipitalis* (Selys).

Range of genus : Bengal, Sikkim, Assam.

1. †**A. occipitalis** (Selys). N. Bengal, Assam.

Anisogomphus occipitalis, Kirby, 1890.

Selys, 1894.

Williamson, 1907.

Laidlaw, 1922.

Fraser, 1923a.

id., 1923b.

id., 1926b.

2. †**A. orites**, Laidlaw. N. Bengal, Assam, Sikkim.

Anisogomphus orites, Laidlaw, 1922.

Fraser, 1923a.

id., 1923b.

id., 1926b.

Davidius stevensi, Fraser, 1923a.

id., 1923b.

3. **A. caudalis**, Fraser. Assam.

Anisogomphus caudalis, Fraser, 1926b.

Genus **Temnogomphus**, Laidlaw, 1922.

Genotype *T. bivittatus* (Selys).

Range of genus : Bengal, Sikkim, Yunnan, N. China.

1. †**T. bivittatus** (Selys). Bengal, Sikkim.
Anisogomphus bivittatus, Kirby, 1890.
 Williamson, 1907.
Temnogomphus bivittatus, Laidlaw, 1922.
 Fraser, 1923*a*.
 id., 1923*b*.
 id., 1926*b*.

2. **T. forresti**, Morton. Yunnan.
Temnogomphus forresti, Morton, 1928.

Genus **Cyclogomphus**, Selys.

Genotype *C. ypsilon*, Selys.

Range of genus : Central and S. India, Ceylon.

1. †**C. ypsilon**, Selys.
Cyclogomphus ypsilon, Kirby, 1890.
 Williamson, 1907.
 Laidlaw, 1922.
 Fraser, 1923*a*.
 id., 1923*b*.
 id., 1924.
 id., 1926*b*.
2. †**C. heterostylus**, Selys. C. India, Ceylon.
Cyclogomphus heterostylus, Kirby, 1890.
 Williamson, 1907.
 Fraser, 1919 (larva).
 Laidlaw, 1922.
 id., 1924.
 Fraser, 1923*a*.
 id., 1923*b*.
 id., 1924.
 id., 1926*a*.
3. †**C. wilkinsi**, Fraser. Mysore, India.
Cyclogomphus wilkinsi, Fraser, 1926*a*.
4. **C. gynostylus**, Fraser. Ceylon.
Cyclogomphus gynostylus, Fraser, 1926*a*.
- C. vesiculosus**, Selys. India.
Cyclogomphus vesiculosus, Kirby, 1890.
 Williamson, 1907.
 Laidlaw, 1922.
 Fraser, 1923*a*.
 id., 1923*b*.
 id., 1926*a*.

[Fraser regards this species as identical with *C. ypsilon*.]

C. ? verticalis, Selys. India.

Cyclogomphus verticalis, Kirby, 1890.

Williamson, 1907.

Fraser, 1919 (larva).

id., 1923a.

id., 1923b.

id., 1926a.

Microgomphus verticalis, Fraser, 1925.

[“ Probably a *Microgomphus*,” Fraser.]

C. ? minuseculus, Selys. Tenasserim.

Cyclogomphus minusculus, Kirby, 1890.

Williamson, 1907.

Fraser, 1919 (larva) ?

Laidlaw, 1922.*

Fraser, 1923a.

id., 1923b.

id., 1926a.

[“ Possibly an *Onychogomphus*, allied to *O. modestus*,” Fraser.]

Gomphus alliance.

Genus **Perissogomphus**, Laidlaw, 1922.

Genotype *P. stevensi*, Laidlaw.

Range of genus : Assam.

1. † **P. stevensi**, Laidlaw. Assam.

Perissogomphus stevensi, Laidlaw, 1922.

Fraser, 1922a.

id., 1923a.

id., 1923b.

id., 1926c.

Gomphus cyanofrons, Fraser, 1923a.

id., 1923b.

Genus **Gomphus**, Leach (= *Aeshna*, Fabr.).

Genotype *G. vulgatissima* (Linn.).

Range of genus : Holarctic, Nilgiri Hills, Assam, Burma, Indo-China, China.

1. † **G. personatus**, Selys. Burma, Assam, Tonkin.

Aeshna personata, Kirby, 1890.

Gomphus personatus, Martin, 1904.

Williamson, 1907.

Laidlaw, 1922.

Fraser, 1923a.

id., 1923b.

id., 1925a.

Gomphus xanthenatus, Williamson, 1907.

Laidlaw, 1922.

Fraser, 1923a.

id., 1923b.

2. **G. abdominalis**, MacL. Shanghai.

Aeshna abdominalis, Kirby, 1890.

Gomphus abdominalis, Ris, 1916.

3. **G. agricola**, Ris. Shanghai.
Gomphus agricola, Ris, 1916.
4. †**G. nilgircus**, Laidlaw. Nilgiri Hills.
Gomphus nilgircus, Laidlaw, 1922.
Fraser, 1923a.
id., 1923b.
id., 1924.
id., 1925a.
5. **G. o'doneli**, Fraser. Duars, Bengal.
Gomphus o'doneli, Fraser, 1922a.
id., 1923a.
id., 1923b.
id., 1925.
6. †**G. auricolor**, Fraser. Tonkin.
Gomphus auricolor, Fraser, 1926.
7. **G. corniger**, Morton. Yunnan.
Gomphus corniger, Morton, 1928.
(? = *Heterogomphus* sp., Fraser, 1923).

Genus **Platygomphus**, Selys.

Genotype *P. dolabratus*, Selys.

Range of genus : Bengal, Burma, China.

1. †**P. dolabratus**, Selys. Bihar, Bengal.
Platygomphus dolabratus, Kirby, 1890.
Williamson, 1907.
Laidlaw, 1922.
Fraser, 1923a.
id., 1923b.
id., 1926b.
2. **P. feae**, Selys. Burma.
Platygomphus feae, Selys, 1891.
Williamson, 1907.
Laidlaw, 1922.*
Fraser, 1923a.
id., 1923b.
id., 1926b.

- P. ?occultus**, Selys. China, Riu-Kiu Is.
Platygomphus ? occultus, Kirby, 1890.
Williamson, 1907.
Gomphus occultus, Oguma.

Genus **Davidioides**, Fraser, 1924.

Genotype *Davidioides martini*, Fraser.

Range of genus : Western Ghats of India.

1. **D. martini**, Fraser. W. Ghats of India.
Davidioides martini, Fraser, 1924.
id., 1926b.

("The genitalia of this species shows alliance with *Burmagomphus* although the facies of the insect does not so much suggest this." Fraser *in litt.*)

Genus **Burmagomphus**, Williamson, 1907 (see also Förster, 1914).

Genotype *B. williamsoni*, Fraser.

Range of genus : India, Assam, Burma, Indo-China, Malaya, Java.

Group *vermiculatus*, Fraser, 1926.

1. **B. williamsoni**, Fraser. Burma.

Burmagomphus vermiculatus, Williamson (nec Martin); 1907.

Fraser, 1923a.

id., 1923b.

Burmagomphus williamsoni, Fraser, 1926b.

2. **B. vermiculatus** (Martin). Tonkin, Annam.

Gomphus vermiculatus, Martin, 1904.

Förster, 1914.

Fraser, 1926b.

3. †**B. pyramidalis**, Laidlaw. W. India.

Burmagomphus pyramidalis, Laidlaw, 1922.

Fraser, 1923a.

id., 1923b.

id., 1924.

id., 1926b.

4. **B. hasimaricus**, Fraser. Duars, Bengal.

Burmagomphus hasimaricus, Fraser, 1926b.

5. **B. siamensis**, Fraser. Siam.

Burmagomphus siamensis, Fraser, 1926b.

†**B. sp.** Malaya.

Burmagomphus vermiculatus, Förster, 1914.

Group *laidlawi*, Fraser, 1926b.

6. †**B. laidlawi** (Fraser). W. Ghats of India.

Gomphus laidlawi, Fraser, 1923a.

id., 1923b.

Burmagomphus laidlawi, Fraser, 1924.

id., 1926b.

7. †**B. siwalikensis**, Laidlaw. Dehra Dun, Duars, India.

Burmagomphus siwalikensis, Laidlaw, 1922.

Fraser, 1923a.

id., 1923b.

id., 1926b.

8. **B. cauvericus**, Fraser. Coorg.

Burmagomphus cauvericus, Fraser, 1926b.

9. **B. v-flavum**, Fraser. N. Shan States.

Burmagomphus v-flavum, Fraser, 1926b.

10. †**B. insularis**, Laidlaw. Borneo.

Burmagomphus vermicularis insularis, Laidlaw, 1914.

id., 1920.*

Burmagomphus insularis, Laidlaw, 1922.

11. **B. inscriptus** (Selys). Java.*Lindenia* (?) *inscripta*, Kirby, 1890.*Onychogomphus inscriptus*, Fraser, 1926.*Burmagomphus jacobsoni*, Ris, 1912.*Burmagomphus inscriptus*, Lieftinck, 1929.

Williamson founded the genus *Burmagomphus* on specimens which he regarded as belonging doubtfully to *vermiculatus*, Martin. Fraser has later named these specimens *williamsoni*, and this species becomes the genotype. The species of Fraser's group *vermiculatus* are probably all "geographical" species.

Genus **Anormogomphus**, Selys.Genotype *A. heteropterus*, Selys.

Range of genus : Persia, Mesopotamia, N. India.

1. **A. heteropterus**, Selys. Punjab, Bihar, Bengal.*Anormogomphus heteropterus*, Kirby, 1890.

Williamson, 1907.

Laidlaw, 1922.

Fraser, 1923*a*.id., 1923*b*.id., 1926*c*.2. **A. kiritschenkoi**, Bartenef. Iraq, Persia, Sind.*Anormogomphus kiritschenkoi*, Bartenef, 1913.Fraser, 1926*c*.Genus **Ophiogomphus**, Selys.Genotype *O. cecilia*, Fourcroy.

Range : Holarctic, Kashmir, W. China.

1. **O. reductus**, Calvert. Kashmir.*Ophiogomphus reductus*, Calvert, 1898.

Laidlaw, 1922.

Fraser, 1925.

O. sp., Morton. Yunnan.

Morton, 1928.

The position of this genus is quite uncertain. It is put here as a matter of convenience. It can scarcely be reckoned in the Oriental fauna.

Genus **Davidius**, Selys.Genotype *D. zallorensis zallorensis*, Selys.

Range of genus : Indo-China, Burma, Assam, China, Japan.

1. †**D. zallorensis zallorensis**, Selys. Himalaya.*Davidius* (?) *zallorensis*, Kirby, 1890.*Davidius zallorensis*, Selys, 1894.

Williamson, 1907.

Ris, 1916.

Laidlaw, 1922.

Fraser, 1923*a*.id., 1923*b*.*Davidius zallorensis zallorensis*, Fraser, 1926*a*.

2. **D. zalloreensis delineatus**, Fraser. Darjiling Distr.
Davidius zalloreensis delineatus, Fraser, 1926a.
3. **D. aberrans aberrans**, Selys. Assam, N. India.
Hagenius (?) *aberrans*, Kirby, 1890.
Davidius aberrans, Selys, 1894.
Williamson, 1907.
Laidlaw, 1922.
Fraser, 1923a.
id., 1923b.
Davidius aberrans aberrans, Fraser, 1926a.
4. **D. aberrans senchalensis**, Fraser. Darjiling Distr.
Davidius aberrans senchalensis, Fraser, 1926a.
5. **D. davidi davidi**, Selys. W. China.
Davidius davidi, Kirby, 1890.
Selys, 1894.
Williamson, 1907.
Davidius davidi davidi, Fraser, 1923a.
id., 1923b.
id., 1926a.
6. †**D. davidi assamensis**, Laidlaw. Sikkim.
Davidius davidi assamensis, Laidlaw, 1916.
id., 1922.
Fraser, 1923a.
id., 1923b.
id., 1926a.
7. **D. fruhstorferi**, Martin. Tonkin.
Davidius fruhstorferi, Martin, 1904.
Williamson, 1907.
Ris, 1916.
8. **D. malloryi**, Fraser. Assam.
Davidius malloryi, Fraser, 1926a.
9. **D. kumaonensis**, Fraser. Kumaon, Assam.
Davidius kumaonensis, Fraser, 1926a.

Onychogomphus alliance.

Genus **Acrogomphus**, Laidlaw, 1925a.

Genotype *A. fraseri*, Laidlaw.

Range of genus : West India, Assam, Burma, Tonkin, Malaya.

1. †**A. fraseri**, Laidlaw. Coorg, S. India.
Acrogomphus fraseri, Laidlaw, 1925a.
Fraser, 1926c.
2. †**A. circularis** (Selys). Burma.
Onychogomphus ? *circularis*, Selys, 1894.
Onychogomphus circularis, Martin, 1904.
Williamson, 1907.
Laidlaw, 1922.*

Fraser, 1923*a*.

id., 1923*b*.

id., 1924*b*.

id., 1926*b*.

3. **A. naninus** (Förster). Tonkin.

A. (Heterogomphus) naninus, Förster, 1905.

Williamson, 1907.

Förster, 1914.

4. †**A. malayanus**, Laidlaw. Malaya.

Acrogomphus malayanus, Laidlaw, 1925*a*.

5. **A. earnshawi** (Fraser). Burma.

Onychogomphus earnshawi, Fraser, 1924*b*.

Onychogomphus sp., Williamson, 1907.

†**A.** sp. Malaya.

Genus **Mesogomphus**, Förster, 1906.

Genotype *M. cognatus* (Ramb.).

Range of genus: Tropical Africa, Madagascar, Ceylon, India, Burma, Malaya, Java, Celebes.

1. †**M. lineatus** (Selys). India, Burma.

Lindenia lineata, Kirby, 1890.

Onychogomphus lineatus, Williamson, 1907.

Morton, 1907.*

Fraser, 1919 (larva).

Laidlaw, 1922.

Fraser, 1923*a*.

id., 1923*b*.

Mesogomphus lineatus, Fraser, 1924.

id., 1924*a*.

Laidlaw, 1924.

2. †**M. reinwardti** (Selys). Java.

Lindenia reinwardtii, Kirby, 1890.

Onychogomphus reinwardti, Williamson, 1907

Laidlaw, 1922.

Fraser, 1925.

Mesogomphus reinwardti, Lieftinck, 1929.

3. **M. frontalis** (Selys). Burma.

Lindenia frontalis, Kirby, 1890.

Onychogomphus frontalis, Williamson, 1907.

Laidlaw, 1922.*

Fraser, 1923*a*.

id., 1923*b*.

id., 1924*b*.

4. **M. capitatus** (Martin). Celebes.

Onychogomphus capitatus, Martin, 1908.

Laidlaw, 1922.

Mesogomphus capitatus, Lieftinck, 1929.

5. †**M. capricornis** (Förster). Malaya.
Onychogomphus capricornis, Förster, 1914.
Lieftinck, 1929.

6. †**M. henryi**, Laidlaw. Ceylon.
Mesogomphus henryi, Laidlaw, 1928.

7. **M. lindgreni** (Fraser). Darjiling Distr.
Onychogomphus lindgreni, Fraser, 1923a.
id., 1923b.
id., 1924a.

8. **M. risi**, Fraser. S. Shan States.
Mesogomphus risi, Fraser, 1924a.

Genus **Lamelligomphus**, Fraser, 1922a.

Genotype *L. nilgiriensis*, Fraser.

Range of genus: India, Burma, Indo-China, Formosa, Java.

1. †**L. nilgiriensis** (Fraser). Nilgiri Hills.
Onychogomphus bforceps nilgiriensis, Fraser, 1922a.
Lamellogomphus bforceps nilgiriensis, Fraser, 1923a.
id., 1923b.
Lamellogomphus nilgiriensis, Fraser, 1924.
id., 1924a.

2. †**L. bforceps** (Selys). Darjiling Distr., Tonkin.
Lindenia bforceps, Kirby, 1890.
Onychogomphus bforceps, Martin, 1904.
Williamson, 1907.
Laidlaw, 1922.
Lamellogomphus bforceps bforceps, Fraser, 1923a.
id., 1923b.
Lamellogomphus bforceps, Fraser, 1924a.

3. †**L. camelus** (Martin). W. China.
Onychogomphus camelus, Martin, 1904.
Williamson, 1907.
Laidlaw, 1922.

4. **L. inglisi**, Fraser. Darjiling Distr.
Lamellogomphus inglisi, Fraser, 1924a.
Lamellogomphus drummondi, Fraser, 1924a.
(*drummondi* is ♀ of *inglisi*, fide Fraser in litt.)

5. †**L. acinaces** (Laidlaw). Coorg, S. India.
Onychogomphus acinaces, Laidlaw, 1922.
Lamellogomphus bforceps acinaces, Fraser, 1923a.
id., 1923b.
Lamellogomphus acinaces, Fraser, 1924.
id., 1924a.

6. **L. malabarensis**, Fraser. Annaimallai Hills.
Lamellogomphus malabarensis, Fraser, 1924a.
Lamellogomphus malabariensis, Fraser, 1924.

7. **L. formosana** (Oguma). Formosa.
Lindenia formosana, Oguma, 1926.
8. **L. cacharensis**, Fraser. Cachar, India.
Lamellogomphus cacharensis, Fraser, 1924*d*.
9. **L. banteng**, Lieftinck. Java.
Onychogomphus banteng, Lieftinck, 1929.
- L. sp.** Yunnan.
L. sp. Morton, 1928.

Fraser (1922*a*) suggested the generic name *Lamelligomphus* for a section of the genus *Onychogomphus*, which I had already defined in the same paper. His suggestion was supported by evidence brought forward by him as to the structure of the larva. The larva was that of *L. nilgiriensis*, which should, I think, be taken as the type of Fraser's genus. Later (Fraser 1923*a*, etc.) the name was altered by its author to *Lamellogomphus* without cause assigned. I believe *Lamelligomphus* should be retained.

Genus **Onychogomphus**, Selys (= *Lindenia*, Kirby, 1890) restr.
Genotype *O. forcipata* (Linn.).

Range of genus: Palaearctic, N. Africa, India, Burma, Malaya, Sumatra, Java, Indo-China.

Group of *grammicus*.

1. †**O. grammicus** (Ramb.). Central and N. India.
Lindenia grammica, Kirby, 1890.
Onychogomphus grammicus, Williamson, 1907.
Laidlaw, 1922.
Mesogomphus grammicus, Fraser, 1924*a*.

Group of *geometricus*.

2. **O. geometricus**, Selys. Java.
Lindenia geometrica, Kirby, 1890.
Onychogomphus geometricus, Williamson, 1907.
Fraser, 1926.
3. †**O. saundersi**, Selys. Burma, Sumatra, Malaya.
Lindenia saundersii, Kirby, 1890.
Onychogomphus saundersii, Selys, 1891.
Kruger, 1898.
Martin, 1904.
Williamson, 1907.
Onychogomphus saundersi, Ris, 1927.
Onychogomphus saundersii, Campion, 1925.
Onychogomphus saundersi, Laidlaw, 1922.
Fraser, 1923*a*.
Onychogomphus saundersi, Fraser, 1923*b*.
id., 1924*b*.
Onychogomphus geometricus
var. *nigrescens*, Laidlaw, 1902.
Onychogomphus nigrescens, Williamson, 1907.

- O. duaricus**, Fraser. Duars, Bengal.
Onychogomphus duaricus, Fraser, 1924a.
? = *Onychogomphus saundersi*, Ris, 1927.
4. †**O. aureus**, Laidlaw. Assam.
Onychogomphus aureus, Laidlaw, 1922.
Fraser, 1923a.
id., 1923b.
id., 1924b.
5. **O. tonkinicus**, Fraser. Tonkin.
Onychogomphus tonkinicus, Fraser, 1926.
Group of *bistrigatus*.
6. †**O. bistrigatus**, Selys. N.E. Himalaya, Assam, Annam.
Lindenia bistrigata, Kirby, 1890.
Onychogomphus bistrigatus, Martin, 1904.
Williamson, 1907.
Laidlaw, 1922.
id., 1923a.
id., 1923b.
id., 1924a.
7. †**O. m-flavum**, Selys. Darjiling Distr., Assam.
Onychogomphus m-flavum, Selys, 1894.
Williamson, 1907.
Laidlaw, 1922.
Fraser, 1923a.
id., 1923b.
id., 1924a.
8. **O. dingavani**, Fraser. S. Shan States.
Onychogomphus dingavani, Fraser, 1924a.
9. **O. striatus**, Fraser. Nilgiri Hills.
Onychogomphus bistrigatus, Fraser, 1922a.
Onychogomphus striatus, Fraser, 1924a.
id., 1924.
Group of *modestus*.
10. **O. modestus modestus**, Selys. Bengal, Sumatra.
Lindenia modesta, Kirby, 1890.
Onychogomphus modestus, Selys, 1894.
Williamson, 1907.
Laidlaw, 1922.*
Fraser, 1923a.
id., 1923b.
id., 1924b.
Ris, 1927.
Onychogomphus modestus modestus, Fraser (in litt.).
11. **O. modestus diminutivus**, Fraser. Darjiling Distr.
Onychogomphus diminutivus, Fraser, 1924b.
Ris, 1927.
Onychogomphus modestus diminutivus, Fraser (in litt.).

12. **O. walli**, Fraser. Upper Burma.
Onychogomphus walli, Fraser, 1924b.

Group ?

13. **O. pulcherrima**, Fraser. Shan States.
Onychogomphus pulcherrima, Fraser, 1927a.

14. **O. annularis**, Selys. Burma.
Onychogomphus annularis, Selys, 1894.
Williamson, 1907.
Fraser, 1923a.
id., 1923b.
id., 1924b.

15. **O. maclachlani**, Selys. Upper Burma.
Onychogomphus maclachlani, Selys, 1894.
Williamson, 1907.
Laidlaw, 1922.*
Fraser, 1923a.
id., 1923b.
id., 1924b.

Incertae sedis.

- †**O. thomassoni** (Kirby). Hainan, Tonkin.
Aeshna thomassoni, Kirby, 1900.
Onychogomphus thomassoni, Martin, 1904.
Williamson, 1907.

(A very fine species, probably referable to an independent genus allied to *Acrogomphus*.)

- O. echinoccipitalis**, Fraser.
Onychogomphus echinoccipitalis, Fraser, 1922.
id., 1923a.
id., 1923b.
id., 1924b.

(Fraser tells me that he thinks this may be a *Lamelligomphus*. I am inclined to suggest that it is a *Mesogomphus*.)

Megalogomphus alliance.
Genus **Megalogomphus**, Campion, 1923.
= *Heterogomphus*, Selys (homonym).
Genotype *M. smithi*.

Range of genus : Oriental, except Philippine Is.

1. **M. smithi** (Selys). Sylhet, Sikkim.
Heterogomphus smithii, Kirby, 1890.
Förster, 1905.
Williamson, 1907.
Laidlaw, 1922.
Fraser, 1923a.
id., 1923b.
Heterogomphus smithi, Fraser, 1923c.
Megalogomphus smithi, id., 1924c.

2. **M. sommeri** (Selys). China.
Heterogomphus sommeri, Kirby, 1890.
 Förster, 1905.
 Williamson, 1907.
3. **M. cochinchinensis** (Selys). Cochinchina, Annam, Cambodia.
Heterogomphus cochinchinensis, Kirby, 1890.
 Martin, 1904.
 Förster, 1905.
 Williamson, 1907.
4. †**M. sumatranus** (Kruger). Sumatra, Borneo.
Heterogomphus sumatranus, Kruger, 1898.
 Williamson, 1907.
 Laidlaw, 1918.
 id., 1920.*
 id., 1922.*
5. †**M. icterops** (Martin). Java, Borneo.
Heterogomphus icterops, Martin, 1902.
 id., 1904.
 Williamson, 1907.
Heterogomphus icterops borneensis, Laidlaw, 1914.
 id., 1920.*
6. **M. unicolor** (Martin). Siam.
Heterogomphus unicolor, Martin, 1902.
 id., 1904.
 Williamson, 1907.
 Laidlaw, 1922.
7. †**M. ceylonicus** (Laidlaw). Ceylon.
Heterogomphus ceylonicus, Laidlaw, 1922.
 Fraser, 1923a.
 id., 1923b.
 id., 1923c.
Heterogomphus sp., Laidlaw, 1924.
8. †**M. hannyingtoni** (Fraser). Coorg, S. India.
Heterogomphus hannyingtoni, Fraser, 1923c.
Megalogomphus hannyingtoni, id., 1924.
 id., 1924d (larva).
9. †**M. flavicolor** (Fraser). Bihar, India.
Heterogomphus flavicolor, Fraser, 1923c.
10. **M. bicornutus** (Fraser). Shillong.
Gomphus bicornutus, Fraser, 1922.
Heterogomphus bicornutus, Fraser, 1923a.
 id., 1923b.
 id., 1923c.
11. **M. risi** (Fraser). Darjiling Distr.
Gomphus risi, Fraser, 1922.
Heterogomphus risi, Fraser, 1923a.
 id., 1923b.
 id., 1923c.
- M. sp.** (Fraser). Yunnan.
Heterogomphus sp., Fraser, 1923.

ON THE METASTERNAL SCENT-GLANDS OF CERTAIN HETEROPTERA

By MAUD D. HAVILAND BRINDLEY.

[Read June 4th, 1930.]

PLATE X AND FOUR TEXT-FIGURES.

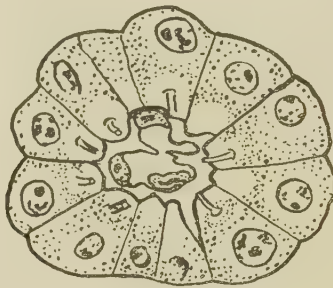
It is well known that many of the adult Heteroptera possess scent-glands which lie in the ventral region of the metathorax. The apparatus has been described for *Pyrrhocoris apterus* by Mayer (10); for *Belostoma* by Locy (9); for *Gerris* by Bordas (2) and Poisson (14). *Cimex lectularius* was first studied by Landois (8) and Kunckel d'Herculais (7). In 1924, Puri (15) gave a detailed account of the odoriferous organs of this species, and recently Kemper (5) has made further researches. In 1929, the present writer (1) described the scent apparatus in *Corixa*; and arising out of that investigation the metasternal glands of other families of bugs have been examined to determine what variation in these organs occurs within the group, and whether it can throw any light on the relationship and phylogeny of the Heteroptera. Unfortunately the available material was scanty, and so far it has not been possible to obtain examples of many important families and subfamilies.

The apparatus follows the same plan in all the forms examined. It consists of (a) a pair of tubular glands communicating with (b) a reservoir of variable form which may or may not be furnished with (c) an accessory gland (the "kidney-shaped organ" of Puri), and which opens to the exterior typically through two orifices which lie ventral to the metapleural region on the anterior margin of, or just within, the metacoxal cavities.

In some forms the tubular glands are simple, though usually much convoluted; in others the collecting duct divides and the secreting cells are arranged in lobes round the secondary ducts, so that the gland is racemose in appearance. The glands are composed of large cells, each of which possesses a small intracellular ductule communicating with a common collecting duct. This collecting duct usually contains nucleus-like bodies whose nature is still in dispute. Puri (15) considered them to be an epithelial lining of very small cells between which the ductules of the great gland cells opened; and my interpretation of the arrangement in *Corixa* agrees with this. Kemper (5), however, denies that these bodies are properly speaking an epithelial layer; and he regards them as chromatin fragments or "nuclear residue," citing as evidence of this that none of the writers who have previously described them have been able to demonstrate the cell walls. After careful study of these bodies in *Palomena* (PENTATOMIDAE), I cannot accept this view, for when stained they do not behave like degenerating chromatin. The tubular glands of bugs are delicate organs, and fixation is apt to produce distortion. The most satisfactory method is to anaesthetise the insect and then dissect out the glands rapidly *under the fixing fluid*. It may be remarked that when treated in this way the large gland cells display little or no vacuolation of the cytoplasm. If sections of the gland are then stained with iron haematoxylin and decolorised until all the colour is removed except that of the nucleoli of the gland cells, the bodies in the duct lumen are easily recognis-

able as nuclei with deeply staining nucleoli which behave under the decolorisation just like those of the gland cells. These nuclei in the lumen are long-oval in form and occasionally bean-shaped. Cross sections show that they lie against the chitinous lining, and are in fact nuclei of the flattened endothelium of the collecting duct. If the reservoir of, for instance, *Corixa* is examined, scattered flattened nuclei of precisely the same character will be found in it. In short, the lumen of the tubular glands is lined with a specialised epithelium, identical and continuous with that of the reservoir into which it extends. This conclusion bears on the homology of the imaginal and nymphal glands which will be discussed later. Text-fig. 1 is from a camera lucida drawing of the gland of *Palomena prasina*. It shows the secreting cells surrounding the lumen at a point which transects three endothelial nuclei. A certain amount of shrinkage has taken place which has resulted in the inner layer tearing away from the ductules of the gland cells which normally penetrate it.

The walls of the reservoir are composed of flattened cells which are often heavily charged with yellow or red pigment granules, and it is lined with thin



TEXT-FIG. 1.—Transverse section through the tubular gland of *Palomena prasina*, L. $\times 1000$.

wrinkled chitin whose folds project into the lumen. The accessory gland, when present, consists of a discrete mass of closely packed elongated cells whose large nuclei are placed at their outer (perivisceral) ends. At the inner ends, which abut on the lumen of the reservoir, the chitinous lining of the organ is invaginated into the cells to form a goblet-shaped depression through which the secretion flows to the lumen.

The variation of structure found in the different forms examined are shown schematically in Plate X; and the order of arrangement of families in the text is that of Reuter (16).

BELOSTOMATIDAE. I have not examined examples of this family. Locy (9) briefly states that two glands emitting "a smell as of ripe bananas" are present, but he does not mention a reservoir.

NEPIDAE. Stink-glands appear to be absent in both *Nepa cinerea* and *Ranatra linearis*.

NAUCORIDAE. The apparatus in *Naucoris cimicoides* consists of a pair of simple but well-developed tubular glands opening into an oval sac-like reservoir, which is 0.9 mm. in diameter and with transparent flaccid walls. There is no accessory gland.

NOTONECTIDAE. In *Notonecta glauca* a pair of long, simple, much convoluted glands are present. The small reservoir, 0.3 mm. in diameter, is oval and

deeply set among the great muscles of the legs. It has neither pigment nor accessory gland.

CORIXIDAE. See Brindley (1).

ACANTHIIDAE. *Salda littoralis* and *S. pilosa* have been examined. The tubular glands are rather short and thick. Their distal ends lie in the concavity of the metasternum, beneath the reservoir, and after curving forward round the latter, they enter it somewhat dorsad. The reservoir is an oval sac, about 0.2 mm. in diameter, and in fresh examples is of a pale yellow colour. The dorsal and lateral walls are thin and non-glandular; but the floor of the reservoir, in juxta-position to, but distinct from, the distal ends of the tubular glands, consists of a thickened epithelium. The cells are closer, their nuclei are larger and more deeply staining, and in some preparations it is possible to see a hemispherical mass of secretion, coagulated by the fixative, resting upon them in the lumen of the reservoir. Histologically this tissue differs from the accessory gland of other forms in that there is little or no thickening of the chitin above it, but there is no doubt that its function is secretion.

GERRIDAE. In *Limnotrechus thoracicus* the organs are much reduced in size, for the diameter of the whole apparatus is only 0.2 mm., but it functions actively and the little reservoir is usually full of secretion. The two flattened glands are composed of somewhat vacuolated cells which discharge into a collecting duct which ramifies through the glandular tissue, branching two or three times on its course. Each duct opens separately into the neck of a small median pear-shaped reservoir which discharges to the exterior through a single transversely extended orifice situated in the middle line near the posterior margin of the metasternum. The flow of secretion is apparently controlled by a pair of short stout muscles which, arising from the hypoderm of the body wall, one on each side below the glands, are inserted on the neck of the reservoir. I know of no similar controlling device in the metasternal glands of other bugs.

HYDROMETRIDAE. I have examined *Hydrometra stagnorum*, but the scent apparatus seems to be absent.

MIRIDAE. Various species of the genera *Calocoris*, *Phytocoris* and *Rhopalotomus* have been examined. In each case the apparatus consists of a pair of somewhat racemose glands with exceedingly thin-walled collecting ducts, and of a large oval reservoir (diameter in *Phytocoris varipes* = 0.3 mm.) which is coloured yellow and drawn out at the anterior angles to the external orifices. There is no accessory gland, but the homogeneous walls of the reservoir are thicker than those of the forms previously described, and the cells composing them have larger nuclei and are not so flattened in section.

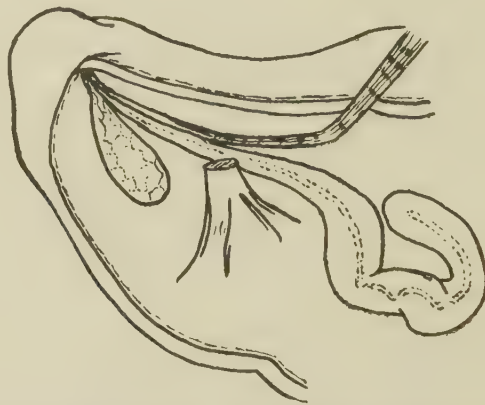
ANTHOCORIDAE. In *Anthocoris nemoralis* the scent apparatus is a conspicuous object in the anatomy of the thorax. The glands are long and somewhat racemose at their distal extremities. The reservoir (0.5 mm. in diameter) is deep orange colour and consists of two large elongated lateral lobes which communicate with a smaller median region. In the posterior wall of the latter is a well-marked oval accessory gland.

CIMICIDAE. *Cimex lectularius*. See Puri (15) and Kemper (5).

NABIDAE. In *Nabis lativentris* and *N. limbatus* the tubular glands are somewhat racemose, and the reservoir, which is rather small (diameter 0.2 mm.) and orange coloured, is deeply lodged in the concavity of the metasternum. It is oval in form, rather longer in the transverse axis, and in the posterior wall is a round accessory gland with the pores well marked in the over-lying reservoir lining.

REDUVIIDAE. Unfortunately the only forms of this large and diversified

family that could be obtained were the related species *Triatoma rubrofasciata* and *Rhodnius prolixus*, living examples of which were kindly sent me from the London School of Tropical Medicine by Dr. P. A. Buxton. The scent apparatus here is unlike all those previously described in that it is duplicate. On the anterior margin of each metacoxal cavity inside the thorax is a prominent curved knob of chitin which probably represents the furca. (Text-fig. 2.) Along the outer side of this knob the great nerve to the third leg passes back from the thoracic ganglion. On the inner side and behind it lies a small tubular twisted gland which has an exceptionally strongly marked central duct and lateral ductules from the secreting cells. This stink-gland passes laterally into a groove which runs along the internal face of the emarginated edge of the metacoxal cavity. Within the groove lies a minute pear-shaped reservoir (0.06 mm. in diameter) with a long neck. The gland enters the latter just above its orifice which communicates with the exterior by a small pore. This apparatus is functional, for the reservoir usually holds a drop of secretion and the gland shows no sign of degeneration. Moreover, fitting neatly in the groove beside the gland and reservoir is a curved rod of chitin whose distal end rests



TEXT-FIG. 2.—Right scent apparatus of *Rhodnius prolixus* showing gland, reservoir, and retractor muscle of the chitinous rod which closes the orifice of the latter. $\times 100$.

against the neck of the latter. On the proximal end of this rod is inserted a long slender muscle which passes up between the large muscles of the legs and arises apparently from the upper margin of the pleuron. Contraction of the muscle draws the rod inwards and upwards and releases the constriction on the neck of the reservoir, thus allowing the egress of the secretion; and in relaxation the rod presumably returns by elasticity to its original position.

PYRRHOCORIDAE. Mayer (10) states that in *Pyrrhocoris apterus* the adult apparatus consists of a bean-shaped gland with branching collecting ducts, and of a spherical reservoir drawn out into a somewhat long neck. Through the kindness of Mr. L. Eastham, who placed at my disposal some material collected in Trinidad by the late Dr. Withycombe, I have examined the apparatus of *Dysdercus howardi*, which differs fundamentally from that of *Pyrrhocoris* as described by Mayer. The tubular glands are moderately developed and lie in front of, and partly beneath the reservoir. The latter (about 1.2 mm. in diameter) consists of two oval chambers, longer in the transverse axis, and heavily pigmented. Each opens laterally to the exterior by a slit-like orifice,

and communicates with the other by a narrow median canal running transversely across the sternum. On the posterior wall of each lateral chamber is a large round accessory gland.

MYODOCHIDAE. In *Scolopostethus affinis*, the tubular glands are racemose and fairly well developed; and the reservoir is a pale yellow thin-walled sac (0.3 mm. in diameter) without an accessory gland.

PIESMIDAE. In *Piesma quadrata* there is no scent apparatus.

PENTATOMIDAE. In *Palomena prasina* and *Elasmotethus griseus* the glands are very large and branch with numerous secondary lobes, but the collecting ducts are not strongly marked. They lie freely in the body cavity on either side of the huge subrectangular reservoir, which in *P. prasina* is 1.6 mm. in transverse diameter. The whole wall of the reservoir, except for the anterior margin and efferent ducts, is thick and glandular, heavily pigmented, and composed of elongated closely packed cells with large nuclei. In addition to this, an accessory gland is present. If mature reservoirs are macerated in potash, or stained and sectioned, a narrow band is seen to extend in the horizontal plane round the ventral surface from one efferent duct to the other. This band is part of the chitinous lining of the organ thickened and punctured by the mouths of the numerous invaginations into the underlying cells which are here elongated and set more closely and stain somewhat differently from those in the rest of the reservoir wall. It is often possible to see these chitinous funnels still filled with dark plugs of secretion coagulated by the fixative.*

Incomplete as the foregoing account of the scent apparatus in the Heteroptera necessarily is, it is perhaps permissible at this point to consider whether any light is thrown on the relationships and phylogeny of the group. A character to serve such purpose must be not only ancient but have been relatively little affected in its evolution by environmental conditions. That the possession of scent-glands in bugs is of longstanding is suggested by their widespread occurrence in the group. It is usually accepted that the CORIXIDAE represent a relatively early offshoot from the primitive Heteropteron stem; yet they possess well-developed metasternal glands, homologous in form and structure with those of other families of Heteroptera.

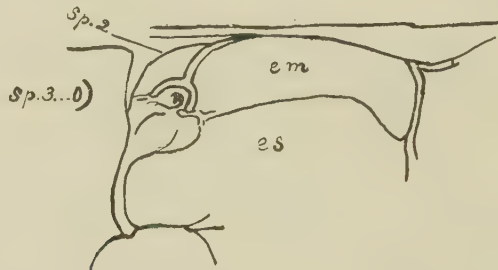
Some authors treat the adult thoracic glands as homologous with the dorsal abdominal glands of the nymph, and even carry the relationship of the glands in Heteroptera further back still. Minchin (11, 12), Ottinger (13) and others have described glandular invaginations of the dorsal intersegmental membranes of the fifth and sixth abdominal segments of certain cockroaches. Vosseler (17) showed that the so-called "plicae laterales" on the dorsum of the second and third abdominal segments of some earwigs cover odoriferous pouches. Histologically these structures are very similar to the nymphal glands of bugs: and Kulwiec (6) held that in all three groups they are a heritage from the common ancestor of Orthoptera, Dermaptera, and Heteroptera, which presumably

* Since the above account was written, I have examined well-preserved examples of certain TINGIDAE and COREIDAE. In *Monanthia cardui*, L. (TINGIDAE) the stink apparatus is quite well developed, and consists of two simple tubular glands and a small reservoir. The latter is transversely oval with rather long efferent ducts. The walls are thickened and glandular, and there is no accessory gland.

Through the kindness of Mr. G. A. Currie, who sent me examples from Queensland, I have recently examined adults of *Anorbus rubiginosus*, Guer. (COREIDAE). The stink apparatus is of the type described here for MIRIDAE. The tubular glands are relatively smaller both in diameter and in mass than those of PENTATOMIDAE. The reservoir, which is very large, has no accessory gland, and the pigment is confined to the ventral posterior part of the organ where the wall is thickened and glandular.

possessed a segmental series of these organs, and Gulde (4) is likewise inclined to this view. Kulwicz (6), who figured what he supposed was the course of evolution in the stink-glands, overlooked the tubular glands and endeavoured to identify the glands of *Halobates* with the accessory reservoir glands of such forms as *Cimex* and *Pentatoma*; but there seem notwithstanding to be good grounds for the homology of at least the dorsal glands of bugs with those of cockroaches and earwigs. A difficulty, though perhaps not an insuperable one, is the absence of similar organs in Homoptera. In Heteroptera, the homology of the nymphal with the imaginal glands is problematical. It was held by Kunckel d'Herculais and Kulwicz, but Kemper does not accept it, and the objections that he raises are: (1) The observation that while the metasternal glands are derived from two hypodermal buds, the dorsal glands arise each from a single invagination. (2) The morphological difference in the form of the organs. (3) The position of the glands in the body.

The first argument seems the most cogent, and indeed is almost conclusive unless we suppose that development has been profoundly modified in the long course of phylogeny. The morphological differences seem more apparent than



TEXT-FIG. 3.—Lateral view of the right metapleuron of *Rhodnius prolixus*, to show the external opening of the gland of the first abdominal segment. em = epimeron. es = episternum. sp. 2 = position of second spiracle. sp. 3 = third spiracle. $\times 20$.

real, even after making allowance for similarity of the minute structure due to identity of function. In the nymphal apparatus, which is much less variable between species than that of the adult, the secreting cells are situated on the ventral floor of the sac except at the distal margin, where they spread on to the dorso-lateral surface. The proximal region of the organ serves as a reservoir. The tubular glands of the adult appear to represent the secreting area of the nymph, drawn out into two long convoluted caeca. The view that the lining of the reservoir is extended into the tubular glands confirms me in this opinion; for Kemper's figure of the wall of the nymphal gland of *Cimex* with a regular row of secreting cells lying against the chitinous intima is quite different from the arrangement in *Palomena* (PENTATOMIDAE), where a few enormous isolated gland cells with large trumpet-shaped orifices to their ductules are packed among smaller cells and separated by them from the chitin lining of the lumen. On this view the reservoir of the adult would not be wholly homologous with the non-secretory part of the apparatus of the nymph, but would represent a posterior extension of that part of the dorsal wall which lies between the external orifices into the segment behind. To the argument that in the nymph the glands are intersegmental and dorsal, and in the adult segmental and ventral, it might be replied that the definitive intersegmental membranes of

hemitabolous nymphs, like those of the adult insects, are usually held each to occupy the posterior border of a region of primary segmentation. Hence the dorsal glands whose orifices are situated on these membranes are morphologically segmental, and belong to the same primary segment as their respective overlying definitive tanga. As regards the dorso-ventral position, I have recently observed a pair of organs in the Reduviid *Rhodnius prolixus* which may throw some light on the matter. In the first abdominal segment of the adult insect, one on either side close under the tergite, are two flask-shaped hollow capsules, flattened dorso-ventrally and in size about 0.5×0.1 m. They lie immediately below the third pair of spiracles which open dorsally, but they are unconnected with them. Each opens by a short duct which leads to an orifice just behind the upper posterior angle of the metathoracic epimeron. The walls of the capsules consist of one or two layers of glandular cells and there is an inner layer of non-glandular cells with a chitinous lining investing the lumen of the organ. The latter usually contains a small quantity of oily fluid. The tissue of the wall is honeycombed by canals formed by the invagination of the chitin into the cells. Superficially the organs resemble those described by Vosseler in the earwig, but they differ from these in the absence of large specialised gland cells and of a muscular coat. In *Rhodnius* they are also



TEXT-FIG. 4.—Section through the wall of the gland of the first abdominal segment of *Rhodnius prolixus*. $\times 1000$.

present in the later nymphal stages, but are then small and doubtfully functional. I have not yet observed them in other bugs. Their lateral position with orifices on the pleura are suggestive of an intermediate condition between the dorsal and ventral glands of the rest of the Heteroptera, and it is tempting to regard them as a survival of part of the primitive series of glandular invaginations which the common ancestor of the Orthoptera and Heteroptera presumably possessed. From this point of view the paired orifices of some Pentatomid nymphs acquire a certain significance, though there are equally strong grounds for regarding them as a secondary development.

It is difficult to say whether the reduction of the metasternal glands has been in direct response to environmental conditions; or whether they have not been affected only indirectly by changes in the form of the thorax induced by different habits and movements. Reuter held that an aquatic habitat led to the disappearance of the scent apparatus, and it is true that it is lacking in some groups of water-bugs, but the glands of *Notonecta*, *Naucoris*, *Gerris* and *Corixa* are functional. Degeneration of the scent-organs may equally well take place in terrestrial life, as for example in the PIESMIDAE, in which the nymphal

glands are large * but those of the adults are completely lacking in spite of identical habits at all stages.

It is of interest to consider as well as the data permit, how far the structure of the scent apparatus bears out a system of classification based on other characters. The view taken here is that modification of the stink-glands has always taken the form of reduction or loss of parts. Unfortunately the condition in the OCHTERIDAE, a family which, according to Reuter, represents a very ancient type, is not known. The ACANTHIIDAE which are also generalised in structure, possess tubular glands, reservoir, and accessory gland, though the latter is not greatly developed. The whole apparatus, in correlation perhaps with the structure of the sternum, appears tilted over backwards, so that the posterior wall of the reservoir with the accessory gland has become ventral, and the tubular glands are partly covered by the reservoir which they enter on the dorsal surface. The glands themselves are short and cylindrical, without secondary collecting ducts, a type characteristic of all the Hydrobiotica examined with the exception of *Limnotrechus*. It is perhaps worth remarking that the external characters of the metasternal apparatus of the GERRIDAE and VELIIDAE resemble those of *Corixa* in one point. In *Corixa* the secretion passes from the reservoir in a groove along the anterior margin of the meta-thoracic episternum to a notch in the posterior edge of the mesothoracic epimeron which is furnished with a little tuft of setae which retains and disseminates the fluid slowly. This groove can be traced in some pond-skaters. In *Velia currens* it is well marked, and the lips of the lateral extremity are somewhat swollen and clothed with setae. In *Rhagovelia nigricans* they are produced into a little eminence through which a few hairs protrude. In GERRIDAE the groove is obsolete, and in most forms, as in *Limnotrechus*, the setal tuft has gone also; but in a few (e.g. *Brachymetra*) a bunch of minute and quite functionless hairs persists on the metacoxal plates.

The scent apparatus of *Corixa* agrees with the rest of the structure of this remarkable form, that is to say it appears to be of ancient type, and yet at the same time it is very specialised, for the asymmetry of the reservoir has, so far as is known, no parallel in other Heteroptera. Study of the development suggests that the left side of the organ has degenerated. Puri (15) states that in *Cimex* the accessory gland first appears in the wall of the reservoir as two separate thickenings of the epithelium which later on coalesce to form a single mass. I have (1) observed the same thing in *Corixa*, but here the left-hand thickening soon disappears and the other becomes the accessory gland of the adult. In this light the reservoir of *Dysdercus* has some significance, for it is unique among the types so far examined in that it consists of two lateral chambers, each provided with an accessory gland. In spite of the absence of ocelli, the PYRRHOCORIDAE are usually regarded as an ancient family. Reuter considered that they have several primitive characters; and on account of the structure of the egg he placed them in a special group. The scent apparatus in *Dysdercus* supports this view, but on the other hand the reservoir of *Dysdercus* has nothing in common with that of *Scolopostethus*, though the MYODOCHIDAE and PYRRHOCORIDAE are evidently allied. From the type of *Dysdercus* the specialised scent apparatus of *Rhodnius* might be derived, but examination of many more forms of REDUVIIDAE would be necessary to show whether the same arrangement holds throughout this large and varied family, some of which, such as the EMESINAE, lack scent-glands altogether, while others, such as some of the

* They occur on the third, fourth, and fifth abdominal segments in *Piesma quadrata*, and not on two segments only as stated by Gulde.

STENOPODINAE and HARPACTORINAE (*Zelus*), are highly odoriferous when handled in the field.* The NABIDAE and REDUVIIDAE are generally held to be related, but the scent apparatus, as far as it is known, has nothing in common. That of the NABIDAE is of an interesting generalised type which in form is nearest to that of *Salda*, though less specialised. The reservoir of the PENTATOMIDAE, with the remarkable linear accessory gland which curves round the ventral surface of the organ, might have arisen by enlargement and elongation from a primitive type such as that of *Nabis*. Lastly the relationship of the CIMICIDAE and ANTHOCORIDAE is confirmed by the form of the scent apparatus with the bifid reservoir and accessory gland set between the two chambers.

In the forms just described it is possible to correlate the presence of an accessory gland with a perceptible odour, but with the MIRIDAE this theory breaks down, for some species of *Phytocoris*, *Calocoris*, etc., have a powerful smell but no gland in the reservoir. Kemper considers the possible function of the accessory gland at some length, and his conclusions seem to be supported by the facts as far as they are known. Carius (3) distinguished two elements in the metasternal secretion of *Rhaphidigaster*, one a fatty acid which he called "cimicinic acid" ($C_{15}H_{28}O_2$), and the other a volatile fluid which was the vehicle of the characteristic odour. Kemper suggests that the former is secreted by the accessory and the latter by the tubular glands, and that the two products are mingled together in the reservoir. Further research is needed, but in this connection it is perhaps worth remarking that the secretion produced by *Corixa* differs in character and appearance, though not in odour, according to the age of the insect. The thick white fluid exuded by the dorsal glands of the nymph mixes with water, while the clear oily secretion of the adult metasternal glands does not.

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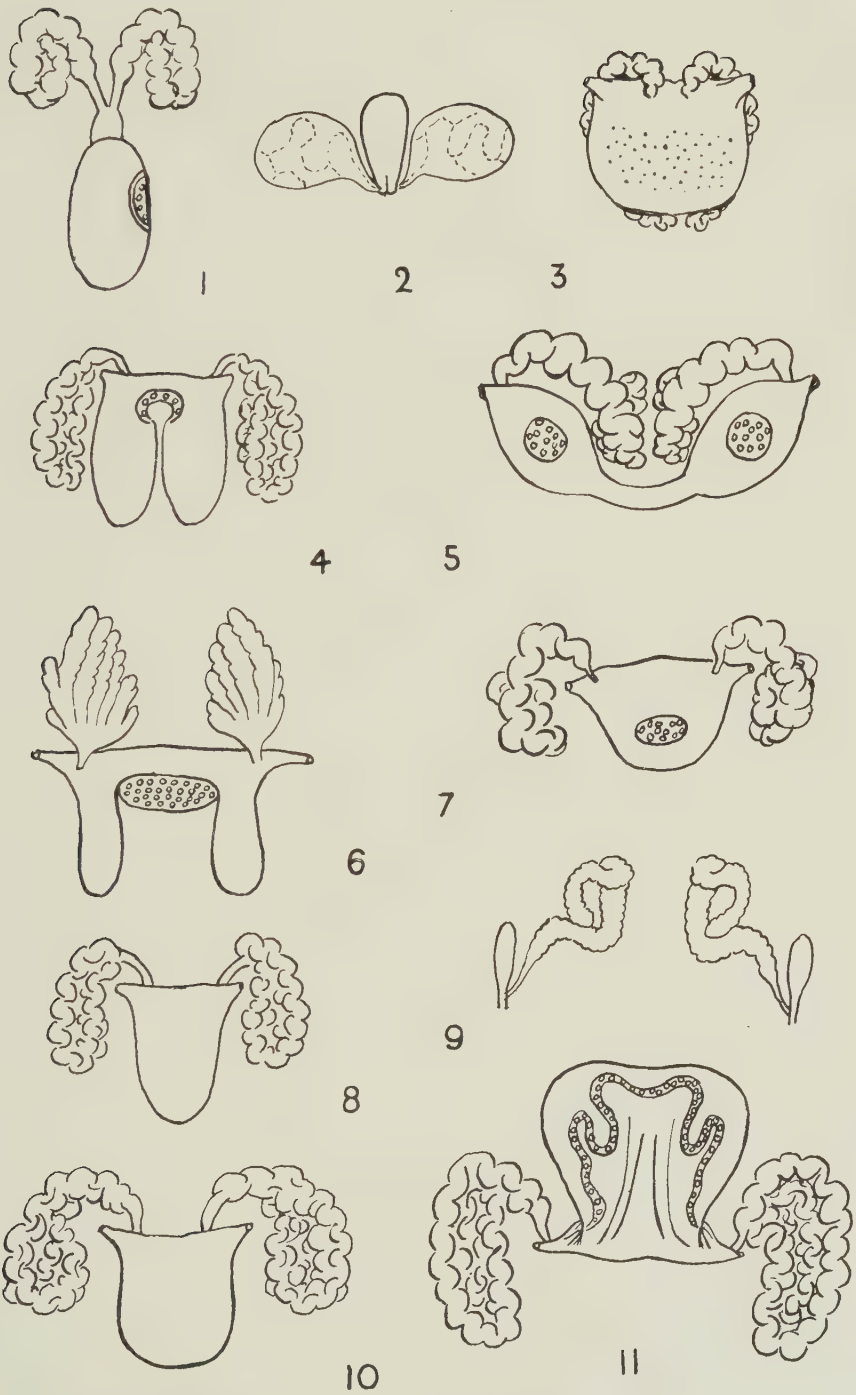
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-

* I can find no abdominal glands in the nymphs of *Rhodnius* and *Triatoma*.

EXPLANATION OF PLATE X.

Modifications of the metasternal scent apparatus in Heteroptera, showing tubular glands, reservoir, and accessory gland when present (diagrammatic).

1, *Corixa*; 2, *Limnotrechus thoracicus*; 3, *Salda littoralis*, with the ventral glandular area of the reservoir stippled; 4, *Anthocoris nemoralis*; 5, *Dysdercus howardi*; 6, *Cimex lectularius* (after Kemper); 7, *Nabis lativentris*; 8, *Scolopostheus affinis*; 9, *Rhodnius prolixus*; 10, *Phytocoris varipes*; 11, *Palomena prasina*, with the reservoir inverted to show the accessory gland.



METASTERNAL SCENT-GLANDS OF HETEROPTERA.

INSECT TERATOLOGY

By E. A. COCKAYNE, D.M., F.R.C.P.

[Read June 4th, 1930.]

PLATES XI, XII, XIII.

PART I. HOMOEOSIS AND HETEROMORPHOSIS.

SINCE I wrote my paper on this subject in 1926, twenty-four unrecorded examples have been given or lent to me, and I have found or had brought to my notice a few references in the literature which are new or which I had overlooked. I am much indebted to Mr. B. W. Adkin, Mr. Willoughby Ellis, Mr. L. G. Higgins, Mr. H. A. Leeds, Dr. W. Gifford Nash, Mr. N. D. Riley, and Mr. W. F. H. Rosenberg for their kind help.

In the interval a very interesting and important paper has also been published by Cappe de Baillon, which, though it throws no light on the cause of homoeosis, proves that the insects cited at the end of my paper as examples of heteromorphosis are in their origin quite unrelated to the examples of true homocosis. Cappe de Baillon has shown that exactly comparable monstrosities are produced in Phasmids from abnormal ova with two micropyles. Such ova give rise to double monsters often so completely fused with one another that a single abnormally placed appendage in addition to the usual complement may be the only outward indication of their duplicity. There can be little doubt that the *Rhytirrhinus deformis*, the *Saturnia pavonia*, and the *Podagricæ*, which I regarded as examples of heteromorphosis, and the *Syrphus perplexus*, which I regarded as one of homoeosis, originated in the same way.

Cappe de Baillon gives other examples of the same kind: a *Carabus nitens* described by Dohrn, which like the *Rhytirrhinus* had a compound eye on the thorax, a *Calathus fuscus* with a small extra eye on the vertex described by de la Brûlerie, a *Vesperus luridus* with a supernumerary eye set on a ring standing up above the centre of the head described by Kiesenwetter, a *Melanoplus femur-rubrum* with two median ocelli described by Blackman, and a *M. differentialis* with four median ocelli described by Glasgow. The pointed conical horn on the heads of the *Clitumnus cuniculus* figured by Fryer may, as de Baillon suggests, be either an unpaired median antenna or the peduncle of an eye, which has disappeared.

His paper also explains how other more complete examples of duplicity were produced, examples which up to now have proved inexplicable. Such are the *Melanitis leda* with an extra abdomen described and figured by Jordan, the female flea, *Xenopsylla cheopis*, with duplication of the internal organs of generation also described by Jordan, and the *Locusta* with two ovipositors, which was, I think, recorded by Chinaglia. The larva of a *Chironomus* with the anterior part of the body divided into two parts, described by Weyenbergh, and the *Xenos bohlsi* with the abdomen similarly bifurcate, described and figured by Hoffmann, are still more perfect double monsters. An exact parallel to nearly all these has been found by de Baillon amongst his Phasmids.

My suggestion that the ectoderm and underlying tissues can be modified so as to produce an appendage, where none normally grows, by a process akin to

that which produces the appendage of another somite instead of the proper one, must be discarded in the light of Cappe de Baillon's researches on the PHASMIDAE. In insects there is as yet no proven or even probable exception to the rule that where there is no appendage there can be no homoeosis.

Ninth Abdominal Somite with Character belonging to Eighth.

There is a preserved larva of *Amorpha populi*, L., from Brighton in the Walsingham collection in the British Museum with two well-formed horns situated one behind the other in the middle line. Both are smaller than the usual single horn, and the first has an oblique yellow stripe running up to it like a normal one. The second appears to be on the ninth abdominal somite. Frohawk figures a similar larva of *Sphinx ligustri*, L., with a second horn, smaller and more curved than the normal one, on the ninth abdominal somite. It was one of twenty bred from the eggs, probably of one female, all of which had a second horn more or less developed. These must be regarded as examples of homoeosis, which arose as a mutation and was presumably inherited.

Antennae replaced by Wings.

Drosophila melanogaster. In March 1921 Bridges discovered a new mutant with pointed wings; the third and fourth longitudinal veins tended to approach each other and had a cross-vein or plexus of small branch-veins near the tip of the wing. In some cultures a rather large proportion of the pointed-wing flies were seen to have antennae that were much modified, apparently in the direction of wings. The antennae had grown out into a structure much like the extra wings of bithorax, *i.e.* there was present a distinct marginal vein with a break in it, as at the base of a normal wing, and with rows of heavy hairs or bristles along it. The rest of the surface had very tiny hairs, as do the surfaces of wings.

Antennae replaced by Legs.

Drosophila melanogaster. A mutant was found by Bridges in which the antennae were distinctly leg-like in character with a series of fine distinct cylindrical joints armed with bristles and with two strong curved bristles as in a normal foot.

These examples of inherited homoeosis are comparable with the mutant of *Drosophila* in which the eyes were partially transformed into antennae and with the two forms of bithorax. The mutant in which the antennae are replaced by wing-like structures is very remarkable, because wings are not considered by most authorities to be homologous with antennae or any other appendages. The question was discussed in my first paper in connection with the *Melitaea maturna*, *Parasemia plantaginis* and *Zygaena filipendulae*, in which one or more legs were replaced by wings, and the *Prionus coriarius*, in which both elytra were replaced by legs. The mutant of *Drosophila* with antennae transformed into legs increases the probability of my suggestion that the similar examples of *Gastrophilus intestinalis* recorded by Bedford and now in the British Museum were the subjects of an inherited abnormality.

I have seen an account of only one additional example of complete homoeosis, but in some respects it differs from any of those described before.

Haltere replaced by Mesothoracic Wing.

Drosophila melanogaster. This specimen is called by Gert Bonnier, who describes and figures it, a meristic variant of an eosin male. On the right side

is a normal wing and balancer, but on the left side the wing gives the appearance of having been cut off at the base, and the balancer is replaced by a wing of normal size and neurulation and normal in all other characters. The metathorax does not appear to be modified. The specimen occurred as an isolated abnormality bred in the course of a genetical experiment.

In the two following examples, which I described and figured in *Trans. Ent. Soc. Lond.*, there is an extra part in the abnormal limb in addition to the homoeosis.

Tibia and Tarsus replaced by Trochanter, Femur, and Tibia.

Apion fuscirostre, F. (Rhynch., Col.)

Tarsus replaced by Tarso-tibia and Tarsus.

Anchomenus oblongus, F. (CARABIDAE, Col.)

All the others are examples of incomplete homoeosis affecting the pattern on the wings of Lepidoptera without affecting the shape or neurulation, and bring the total number of records of this kind from 81 to 112. I have classified these as before and brought the numbers up to date, mentioning only the new examples and those omitted from my first paper.

Substitution of part of Fore-wing (mesothoracic) by part of Hind-wing (metathoracic).

Forty-two examples, thirty unilateral, twelve bilateral.

(1) *Upper surface affected*. Thirteen examples, eight unilateral, six bilateral.

Papilio machaon, L. Two examples. (Ugrjumow and Hochrainer.)

Danaïs chrysippus, L. f. **alcippus**, F. (Described below.)

Amorpha populi, L. Bilateral. (Treitschke cited by Tutt.)

Arctia caia, L. (Described below.)

(2) *Under surface affected*. Twenty-eight examples, twenty-two unilateral, six bilateral.

Brenthis selene, Schiff. Four examples. Bilateral. (Reuss.)

Brenthis euphrosyne, L. (Described below.)

Melitaea athalia, Rott. Six examples. (Described below.)

Melitaea cinxia, L. Three examples. (Described below.)

Melitaea varia, M.-Dürr. Bilateral. (Described below.)

Substitution of part of Hind-wing (metathoracic) by part of Fore-wing (mesothoracic). Fifty-six examples, fifty unilateral, six bilateral, surface affected not stated in two cases.

(1) *Upper surface affected*. Eighteen examples, sixteen unilateral, two bilateral.

Aglais urticae, L. (Described below.)

Malacosoma castrensis, L. (Tutt.)

Dendrolimus pini, L. Bilateral. (Kramlinger.)

Philosamia cynthia, Drury. (Klotz.)

Bryophila perla, Fab. (Barrett.)

Semiothisa notata, L. (Described below.)

(2) *Under surface affected*. Thirty-six examples, thirty-two unilateral, four bilateral.

Aporia (Pieris) davidis, Oberth. (Described below.)

Coenonympha pamphilus, L. (Described below.)

Coenonympha tiphon, Rott. (**davus**, F.) (Described below.)

Erebia aethiops, Esp. ab. **derufata**, Frühst. (Described below.)

Epinephele jurtina, L. Two examples. (Described below.)

Substitution of part of the scaling of one surface of a Wing for that of the other surface. Eighteen examples. All unilateral.

(1) *Upper surface of fore-wing reproduced on under surface*. Four examples.

(2) *Under surface of fore-wing reproduced on upper surface*. Three examples.

Plebeius argus, L. (Described below.)

(3) *Upper surface of hind-wing reproduced on under surface*. Seven examples.

Pyrameis cardui, L. (Described below.)

(4) *Under surface of hind-wing reproduced on upper surface*. Two examples.

Plebeius argus, L. (Described below.) Wing affected not specified in two cases.

The additional examples strengthen the view expressed in my earlier paper that apart from the inherited mutations injury is the primary cause of the phenomenon. The reasons given were twofold, first that homoeosis has been produced experimentally by amputation of an appendage, and secondly that homoeosis in insects captured or bred is often accompanied by other abnormalities such as are known to be produced by trauma during development. In the present series the *Drosophila* had its fore-wing on the affected side represented by a mere stump, and amongst the Lepidoptera the *Aporia davidis* had the affected wing greatly reduced in size and very defective in neuration, and the *Brenthis euphrosyne* had both wings on the affected side small and slightly abnormal in neuration. In both these butterflies the homoeotic area is large, and, as I pointed out before, the larger it is the more likely is it to be associated with other structural abnormalities. Amongst the other Lepidoptera the *Erebia* and one *M. athalia* have the affected wing slightly reduced in size, though the area involved in the homoeosis is small in both cases. One *cinxia* has the opposite fore-wing abnormal in shape, and two *athalia* have asymmetrical markings. The symmetrical error in the neuration of another *athalia* is probably unconnected with the homoeosis.

Though four more families can be added to my previous list the irregular distribution of homoeosis amongst the different families is still more apparent :—PAPILIONIDAE (8), PIERIDAE (4), NYMPHALIDAE (25), DANAIIDAE (1), MORPHIDAE (2), SATYRIDAE (27), LYCAENIDAE (21), ZYGAEINIDAE (9), SPHINGIDAE (1), ARCTIIDAE (9), LASIOCAMPIDAE (2), SATURNIIDAE (1), NOCTUIDAE (10), GEOMETRIDAE (4), HEPIALIDAE (1), TINEIDAE (1). The liability of certain genera and even of certain species to this defect becomes even more evident than before. The additions bring the number of *Coenonympha pamphilus* up to 17, of *Melitaeas* to 16 including 12 *athalia* and 3 *cinxia*, of *Papilios* to 5 including 3 *machaon*, of *Erebias* to 5, of *Epinephele jurtina* to 3, *Arctia caia* to 8, and *Semiothisa notata* to 2. I drew attention before to the fact that in some genera homoeosis nearly always affects the fore-wing and in others the hind-wing, and that there is a similar predilection for one surface in one genus or species and for the other in another. In the SATYRIDAE the under surface of the hind-wing is nearly always the part affected and the five additional examples agree with

the majority in this respect, the *tiphon* in particular closely resembling most of the *pamphilus*. In all the *Melitaeas* on the other hand the under surface of the fore-wing is the part affected. The ten now described for the first time are astonishingly like those reported previously. The area affected is confined to the discoidal cell and the part external to the disc between nervures 3 and 7. The fact that so many *athalia* have come from one locality and that the *cinxia* were all taken close together arouses the suspicion that in *Melitaea* the condition may be an inherited defect. The *Arctia caia* is the sixth with the upperside of the fore-wing affected and the fourth in which both fore-wings show areas of homoeosis. The second *Semiothisa notata* has the same part affected on the upper surface of one hind-wing that is affected on both sides in the first.

The *Brenthids* differ from any of the other examples of homoeosis. Instead of small but perfect or nearly perfect areas of scaling proper to one wing appearing on the homologous parts of another the whole surface of a wing is transformed. In the *euphrosyne* the whole of the underside of a fore-wing is modified so as to approach a hind-wing in coloration though not in shape or neurulation. In the *sylene* both the fore-wings are affected and the change to the colour and pattern of a hind-wing is much more complete.

The *Bryophila perla* differs still more from any other example of homoeosis. The pattern of the fore-wing reappears on the hind-wing but with its colours reversed as in a photographic negative, the dark parts being light and the light parts dark.

***Papilio machaon*, L.**

Hochrainer.

On the upper surface of the right fore-wing a streak of pale yellow scales runs parallel with the nervures through the distal half of the black bar that crosses the middle of the discoidal cell, and another similar streak cuts into the black basal area running into it from its distal edge at a point halfway across the cell. The two streaks are in line with one another, and the corresponding part of the hind-wing is of the same yellow colour. The figure shows no abnormality of size or shape.

***Papilio machaon*, L.**

Ugrjumow.

On the upper surface of the right fore-wing at the anal angle there is a perfect ocellus like that on the upper surface of the right hind-wing at the anal angle. From the figure there appears to be no crippling and no obvious reduction in size or abnormality in neurulation.

***Danais chrysippus*, L. f. *alcippus*, F. ♀.**

Bitje, Ja River, Cameroons, 2000 feet.

On the upper surface of the right fore-wing is some scaling proper to the upper surface of the right hind-wing. From a point just posterior to nervure 3 to the costa white scales are sprinkled thickly over the surface from a point just internal to the disc to a point just external to the subapical row of white spots, which remain visible. The white scales resemble those on the hind-wing and are not deformed or unpigmented. The underside is normal and there is no evidence of injury. Though in no place are the white scales as dense as on the hind-wing I think this is an example of homoeosis. In specimens in which pigment fails to develop both surfaces are always affected in the same area and to about the same degree, and curling up of many of the scales is usual.

I am indebted to the generosity of Mr. Rosenberg for this interesting butterfly.

***Amorpha populi*, L.**

Treitschke cited by Tutt.

There is a red patch at the base of both fore-wings resembling that found at the base of the hind-wing.

***Arctia caia*, L. ♀.**

Meldon. Bred by J. Finlay, 1895. B. W. Adkin Coll.

Part of the pattern of the upper surface of both hind-wings is repeated on the upper surface of both fore-wings. In the right fore-wing the three outermost white costal markings have streaks of red scaling in them and the largest of these encroaches considerably on the brown apical mark, where the corresponding part of the hind-wing is red. Streaks of blue-black scales are also present in the two brown markings near the costa, which are homologous with the two blue-black spots of the hind-wing lying most externally and most anteriorly. One of these streaks is continuous with red streaks in the white marks internal and external to it. In the left fore-wing streaks of red lie in similar positions and two of them cut into the brown marking along the termen, where the homologous part of the hind-wing is red. There is also a large red area near the inner angle almost completely replacing the normal white marking of this portion of the wing. The brown marking along the termen is smaller in this wing, and a little brown spot belonging to it lies isolated just internal to its main part in the red area, but surrounded by a narrow ring of yellow scales like those round a blue-black spot in a hind-wing. Considerable parts of the brown markings along the inner or posterior margin are replaced by blue-black, and there are streaks of blue-black scales in the brown markings of the anterior part of the wing, one continuous with a red streak in the white marking both internal and external to it. In every part the homoeosis is perfect, blue-black and red scales occurring only where such are found in the corresponding parts of the hind-wing. The inner margin of the left fore-wing is incompletely expanded, but the size, neurulation, and underside of both are normal. (Plate XI, fig. 7.)

***Brenthis euphrosyne*, L. ♀.**

L. W. Newman, North Kent, June 1927.

The wings on the right side are very small, the fore-wing measuring 19 mm. $\times$ 12.5 mm. instead of 21 mm. $\times$ 14 mm., and the hind-wing 12.5 mm. instead of 16 mm. Nervure 7, instead of branching and each branch reaching the termen, branches at the usual point, but the posterior branch ends blindly and the anterior branch divides again close to the termen. There is an indentation of the termen between 4 and 5.

On the upper surface of the fore-wing the markings on the right differ from those on the left; the submarginal spots are small but the black markings outside the disc are larger in proportion to the size of the wing and form a band, and those nearer to the base are fully as large as normal in spite of the smallness of the wing. On the under surface of the hind-wing the silver marks, especially those of the marginal lunules, are yellower on the right side than on the left. The whole of the under surface of the right fore-wing approximates in colour and markings to that of a hind-wing. The submarginal black spots are reduced to the size of those in the hind-wing; the lunules, black in a normal fore-wing and silver in a hind-wing, are yellow or slightly silvery according to the incidence of the light. The black markings crossing the wing transversely outside the disc are reduced in size and altered in shape to resemble those of the hind-wing; and external to them the ground-colour is yellow forming a band as on the hind-wing. Between 4 and 5 the black mark on the disc is very narrow and mixed with a large number of yellow scales instead of forming a broad completely black bar; in a hind-wing it can just be traced as a faint black line cut-

ting the silver patch in two; the outer part of the discoidal cell is silver in a hind and chestnut in a fore-wing, but in this insect it is yellow with a silver tint in some lights; between the disc and the black mark outside it the ground-colour is a clear yellow instead of chestnut, and is exactly like the homologous area of the hind-wing. In the discoidal cell there is internal to the silvery yellow patch first a narrow black line as in a hind-wing instead of the normal broad one, and then nearer to the base a narrow elongated black mark with a yellow patch posterior to it representing the yellow spot with a black dot in the centre to be found in the hind-wing; the other big black spot in the discoidal cell of a normal fore-wing is missing. In the monochrome illustration the resemblance to a hind-wing is fairly obvious, but in the natural colours of the butterfly itself it is much greater. (Plate XI, fig. 3.)

***Brenthis selene*, Schiff. 1 ♂, 3 ♀♀.**

Reuss figures a male and female, and says that with two more females they were bred by Herr Huhst from a locality near Berlin amongst five thousand specimens. The two figured show that nearly the whole of the underside of both the fore-wings of each have the colour and pattern of the underside of the hind-wings. Only a few markings are missing on one or other side. They are the most perfect examples of homoeosis which have been recorded. So far as can be seen there is no reduction in size or maldevelopment of the wings. Reuss has named them f.h. *futura*.

Th. Reuss, 1929, *Int. Ent. Z.*, **22**: 433.

***Melitaea athalia*, Rott. ♀.**

W. Crocker, E. Kent. This was erroneously recorded as *M. cinxia*, 1926, *Ent. Rec.* **38**: 112.

On the underside of the right fore-wing a streak of the colour and pattern of the right hind-wing runs through the middle of the wing from the base almost to the termen. The first part runs through the middle of the discoidal cell, but does not affect any of the black markings of the normal fore-wing. There are a few light scales and extra hairs at the extreme base, then further out is a thin stripe of cream-coloured scales with some white hairs at its basal end, representing part of the triangular cream-coloured mark at the proximal end of the cell, and a shorter stripe of the same colour representing part of the circular spot near the distal end of the cell. The presence of hairs in the proximal stripe is interesting, because this part of the hind-wing is hairy but of the fore-wing smooth. There are a few lighter chestnut scales between the two oblique black lines at the disc just as in a hind-wing, instead of all dark ones as in a fore-wing. Just external to the more distal of these two lines between 5 and 6 a thin stripe of cream-coloured scales represents part of the narrow transverse creamy band which goes right across the hind-wing, and this stripe is edged distally by black scales like the band in the hind-wing. External to this in the hind-wing is a broader silvery transverse band delimited by black distally and interrupted by black along the nervures. Part of this is represented between 5 and 6 by a silver stripe occupying the anterior part of the cell, and replacing the anterior half of the black mark proper to this part of a fore-wing. Another part of it is represented between 6 and 7 divided into two by a line of black scales, the middle part of the black spot, and chestnut scales, part of the ground-colour. These silver areas have black scales delimiting their outer boundary. Just in front of 6 and just distal to these black scales a stripe of creamy scales runs nearly to the marginal lunule and crosses into cell 6 beyond the black wedge-shaped spot of the normal fore-wing. These scales correspond in colour with the ground-colour of the homologous part of the hind-wing. The varied markings of the hind-wing are repeated exactly in the homoeotic area of the fore-wing. The affected wing is completely expanded and of full size and has the normal neuration, but the termen is more convex

than that of the opposite wing. Its upperside also differs; the first black transverse line outside the disc lacks the projection towards the base between 4 and 5, and between 6 and 7 there are two black streaks not present in the opposite wing lying between the first and second transverse black lines. (Plate XI, fig. 1.)

Melitaea athalia, Rott. ♀.

Blean Woods, June 1922, W. G. Nash.

On the under surface of the left fore-wing between 5 and 6 in place of the black spot external to the disc and extending further out towards the termen than the normal black spot is a narrow oval patch of cream-coloured scales surrounded by a narrow border of black ones.

Melitaea athalia, Rott. ♂.

Blean Woods, June 1922, W. G. Nash.

The specimen is an aberration very lightly marked with black on the under surface, the row of black spots external to the disc being represented by only a few black scales in each cell. The large spot between 1 and 2 is of normal size on the right, but almost obsolete on the left. On the under surface of the right fore-wing between 5 and 6 an oval patch of cream-coloured scales runs obliquely outwards and forwards from 5 extending halfway across the cell; a black stripe separates the distal end of the patch from the brown ground-colour and becoming broader diverges slightly from the anterior aspect of the patch ending at a point opposite the middle of its long axis.

Melitaea athalia, Rott. ♂.

Blean Woods, June 1928, W. G. Nash.

There is an almost symmetrical abnormality of neuration, 2 and 3 springing from a common stalk, which is longer on the right fore-wing. On the under surface of the right fore-wing between 5 and 6 the black spot external to the disc is replaced by an oval patch of cream-coloured scales bordered by a thick strip of black scales starting a quarter of the way from the basal end of its anterior aspect and ending three-quarters of the way from the basal end of its posterior aspect. Slightly distal to this is a second oval patch of cream-coloured scales surrounded, except along the middle third of its posterior aspect, by a narrow line of black. Here the black scales instead of running basally turn forwards and nearly cross the cream patch.

Melitaea athalia, Rott. ♂.

Blean Woods, June 1922, W. G. Nash.

On the under surface of the right fore-wing between 5 and 6 in the position normally occupied by the black spot external to the disc a large patch of cream-coloured scales runs from 5 forwards and outwards to the middle of the cell. There are many scattered black scales lying between the patch and 6, and the patch itself is bordered by a line of black on the anterior aspect at its point of origin from 5 and at its rounded distal extremity. Slightly external to it is another patch of cream-coloured scales nearly circular and surrounded by a line of black ones except at a point near the middle of its anterior aspect. Immediately external to and a little anterior to this is a smaller patch of pale ochreous scales which touches 6 and nearly reaches the submarginal shade.

Melitaea athalia, Rott. ♂.

Blean Woods, W. G. Nash.

On the under surface of the right fore-wing up the middle of the discoidal cell a narrow streak of cream-coloured scales runs from the outermost of the three black cross-bars to the disc, dividing into two for the outer third of its course. Between 5 and 6 a black streak runs from the posterior aspect of the black spot, which lies external to the disc, and is of the same length as the spot itself. A roughly triangular patch of cream-coloured scales with the apex pointing towards the base of the wing extends from the distal end of the streak, and is bordered on its anterior and external aspects by a line of black scales, and a short black streak runs distally from its anterior and external corner. The affected wing is slightly reduced in size. In all Dr. Nash's specimens the upper surface is normal.

Melitaea cinxia, L. ♂.

I. of Wight, June 1919, W. G. Nash.

On the under surface of the left fore-wing between 5 and 6 and in contact with 5 is an oval patch of whitish scales separated into two parts by a few black ones and with some black scales along the anterior aspect of its distal half. The black spot external to the disc lies immediately external to the patch and is about twice the size of the one on the right fore-wing. The abnormal area is about 2 mm. long.

Melitaea cinxia, L. ♀.

I. of Wight, June 1919, W. G. Nash.

On the under surface of the right fore-wing between 6 and 7 the black spot external to the disc is cut in two by whitish scales.

Melitaea cinxia, L. ♂.

I. of Wight, June 1919, W. G. Nash.

On the under surface of the left fore-wing between 4 and 5 about 1 mm. external to the disc is a circular patch of whitish scales touching 4 and extending halfway across the cell. Immediately distal to it is a roughly triangular patch of black scales and distal to this a small oval patch of whitish ones. Extending from the distal end of this there lies in the middle of the cell an oval patch of white scales completely encircled by a line of black ones. The proximal part of this patch occupies the normal position of the black spot external to the disc, but its long axis is double the diameter of the normal black spot. The abnormal area is 3.5 mm. long. The right fore-wing is broader than the left and has a truncated apex.

In none of these three specimens is there any abnormality of neuration or crumpling of the wing, and their upper surfaces are normal.

Melitaea varia, M.-Dürr. ♀.

L. G. Higgins, Bérissal, 30.vii.1926.

An example of bilateral homoeosis which is nearly symmetrical. On the under surface of the left fore-wing posterior to but touching 2 is a fleck of silver with some black scales external to it and outside them a little streak of pale yellow; between 2 and 3 and between 3 and 4 there are a few groups of pale yellow scales and black scales; between 4 and 5 there is another short silver streak, and between 5 and 6 a larger streak of silver with a few black scales distal to it and still more distal a few yellow scales. These all represent parts of the broad transverse silver band of the hind-wing, the delimiting line of black external to

it, and the narrow transverse yellow band lying still nearer to the margin. Near the apex of the discoidal cell are two groups of pale yellow or slightly silvery scales representing part of the silver spot in the discoidal cell of the hind-wing. Though not an exact replica of the hind-wing pattern these markings are a close copy of them and occupy homologous areas. On the under surface of the right fore-wing between the inner border and 1 is a stripe of pale yellow scales, and between 1 and 2 are eight small groups of silver or yellow scales; between 3 and 4 are some scattered yellow scales, and between 5 and 6 is a small silver patch bounded externally by a few black scales with a number of pale yellow ones lying still further out. All these areas of abnormal scaling represent the same hind-wing markings as the similar areas on the fore-wing of the opposite side. The insect is perfectly expanded and the neuration and upper surface are normal. (Plate XI, fig. 2.)

Aglais urticae, L.

I. of Wight, Thos. Salvage. A. F. Hemming Coll. H. Willoughby-Ellis Coll.

The whole of the discoidal cell on the upper surface of the right fore-wing is occupied by a very perfect replica of the pattern and colours proper to the same area on the upper surface of the right fore-wing. At the base is the usual dark area followed by a patch of fulvous ground-colour; distal to this lies the posterior part of the first black costal bar, then an area of yellowish ground-colour, and distal to this the posterior part of the second black costal bar; just behind 5 a streak of yellowish scales runs outwards from the black bar halfway to the dark marginal area, and there is a wedge of similar scales halfway between 4 and 5; there is also a wedge of fulvous scales just behind the median nervure distal to the dark basal area. The wing is perfectly expanded and not reduced in size; its neuration and under surface are normal. (Plate XII, fig. 4.)

Semiothisa (Macaria) notata, L. ♀.

G. V. Bull. Bred, Beckley, E. Sussex, June 23rd, 1928.

On the upperside of the left hind-wing there is a conspicuous patch of black scales between 3 and 4 and two or three more between 2 and 3. This is a replica of part of the black mark on the fore-wing, the greater part of which lies between 3 and 4 with extensions between 2 and 3, and 4 and 5. In the hind-wing there is also a black speck on nervure 2 which is the same size as that in the same situation on the fore-wing, but unlike that on the opposite hind-wing. The affected wing is perfectly expanded, but much smaller and a little different in shape from the opposite wing. The underside and neuration are normal. (Plate XII, fig. 5.)

Malacosoma castrensis, L. ♀.

The right hind-wing is banded as in a fore-wing; it is the buff type with two yellow bands distinctly developed on the right hind-wing as well as on the fore-wings.

Recorded by Bond and Tutt.

Dendrolimus pini, L. ♀.

On the upperside of both hind-wings there are nearly symmetrical areas showing the colour and markings of the homologous parts of the fore-wings, grey, whitish, and black, between *M*3 and *Cubitus* *C*2; the rest of the hind-wings is of the usual red-brown. The underside is normal; the neuration is normal and the wings are perfectly expanded and not appreciably smaller than usual.

Described and figured by Kramlinger.

***Philosamia cynthia*, Drury. ♂.**

On the upperside near the margin of the anterior border of the right hind-wing is a little ocellus measuring only 1.5 mm. in diameter like the apical ocellus of the fore-wing, with all the colours as in that ocellus.

Described by W. Klotz.

***Bryophila perla*, Fab.**

The following is a quotation from Barrett. "But the most remarkable aberration known to me in this, or almost in any species, is a specimen in the collection of Mr. S. J. Capper, in which the fore-wings and right hind-wing are normal, but the left hind-wing has a wonderful reproduction of markings of the fore-wing, as though they had been printed on it in reverse, the angulated black lines and the white intermediate spaces being very distinctly and wonderfully shown."

***Pieris davidis*, Oberth. ♂.**

Siao-Ouisi, China. Père Emile Monbeig, Jan. 1914.

A large area on the underside of the right hind-wing shows the colour of the underside of the right fore-wing. The wing is very small and narrow, 22×14 mm. instead of 25×19 . The neurulation is abnormal; 6 is very thin near its point of origin, then becomes of normal width, but fails to reach the termen. The anterior part of the disco-cellular is very thin and not in line with the posterior part; for the first third of its course 3 is thin and at this point is joined by a thin branch from 2, it then becomes normal in width but fails to reach the margin; 1a is very short and ends blindly. The black marking along the nervures is absent or faint where the nervures are thin. At the extreme base the inner margin is edged with black and the wing between it and 1a is of the usual bright yellow, but the wing suddenly becomes narrower, and from this point onwards resembles the corresponding part of the fore-wing in having no black margin and a white ground-colour. The area bounded in front by 4 and by the median has a white ground with certain exceptions, a tiny patch in the basal part of the discoidal cell and a more elongated one in its central part, a wedge-shaped area extending from 4 to 3 and slightly behind 3, two tiny patches in the basal part of cell 3, and the basal part of cell 2 confined posteriorly to the basal third of 1b but running further out anteriorly as far as the basal third of 2. The nervures are more heavily marked with black than those of the fore-wing, but the white parts of the wing near the inner margin are like the corresponding part of a fore-wing in having no long thin hairs. (Plate XI, fig. 6.)

***Coenonympha pamphilus*, L. ♂.**

A. E. Sabine, Co. Clare, June 1926.

On the underside of the right hind-wing between 1a and 2 and between 2 and 3 are some small irregular patches of tawny scales like those on the corresponding parts of the underside of the fore-wing. The development of the wing, the expansion of the wing and its upperside and neurulation are normal.

***Coenonympha tiphon*, Rott. (davus, F.) ♂.**

A. W. Peach, Forres, July 1912. E. B. Nevinston Coll.

There is part of the pattern of the under surface of the right fore-wing exactly reproduced on the under surface of the right hind-wing. There is a large patch of fulvous scaling 6 mm. long occupying the whole width of the cell between 1b and 2, starting close to the margin and ending in two projections pointing towards the base. The patch extends across the

cell between 2 and 3, gradually leaving the margin and becoming narrower, and ends as a triangular projection into cell 3. A small isolated group of fulvous scales lies nearer to the base just in front of 2. The white ocellus between 1b and 2 is absent and that between 2 and 3 is reduced in size and without the central black dot. The size, expansion, neuration, and upper surface of the affected wing are normal.

***Erebia aethiops*, Esp. ab. *derufata*, Frühst. ♀.**

L. G. Higgins, 17.viii.1925.

On the under surface of the left hind-wing there is an area with the pattern and coloration of the corresponding part of the left fore-wing. Between 4 and 5 in place of the grey band there is a bright tawny patch with a black spot with a white ocellus situated in it. The area is an exact replica of the corresponding part of the fore-wing except that the spot in the hind-wing does not quite extend back to 4. The affected hind-wing is slightly smaller than the other. The neuration and upperside are normal and the wing is perfectly expanded. (Plate XI, fig. 5.)

***Epinephele jurtina*, L. ♀.**

H. A. Leeds, Eynsford, Kent, July 12th, 1926.

From base to margin on the under surface of the left hind-wing scattered over its posterior three-quarters are numerous streaks and patches of scales like those on the corresponding part of the under surface of the left fore-wing. They lie between the inner border and 1a, 1a and 1b, 1b and 2, 2 and 3, 3 and 4, 4 and 5, and in the discoidal cell. The most conspicuous are the bright orange-brown patches lying in the light band, but the patches of scales proper to a fore-wing are easily visible even in the dark basal and marginal areas of the wing. Unfortunately the parts affected do not include the area homologous with that occupied by the ocellus. The wing is slightly crumpled along the inner border, but it is not reduced in size. The neuration and upperside are normal.

***Epinephele jurtina*, L. ♀.**

H. A. Leeds, Monk's Wood, Hunts., 16.vii.1929.

Three narrow stripes, which in colour resemble those on the corresponding part of the under surface of the right fore-wing, run from base to outer margin on the under surface of the right hind-wing. The first lies midway between 5 and 6, the second midway between 6 and 7, and the third runs along the anterior border reaching the outer margin in the cell between 7 and 8. The size, expansion, neuration, and upper surface of the affected wing are normal.

***Plebeius argus*, L. ♀.**

H. A. Leeds, Kent, 19.vii.1929,

Part of the pattern of the under surface of the left fore-wing is imperfectly reproduced on the upper surface. The posterior half of the black discal spot with its white ring is present. The submedian black spot with its white ring, though smaller in size, occupies exactly the same position as the one on the under surface, and from it two streaks of white and pale blue scales run out towards the termen, and beyond them a few black scales are present in the position of the black crescents of the under surface. Distal to these are a few white scales in the position of the orange lunules of the under surface. There is no spot between 3 and 4, but apart from this there is the same abnormal scaling. Between 2 and 3 there are a few black scales representing the spot, and distal to them are two streaks of pale blue scales; a few dark chestnut scales lie in the position of the orange lunule of the under surface. The scales running out from the region of the submedian spots are pale

blue serrated ones instead of pure white ones, and do not occupy exactly the same area as the white scales of the under surface. The under surface and neuration of the wing are normal and the size and expansion perfect. (Plate XI, fig. 8.)

***Pyrameis cardui*, L.**

L. W. Newman, N. Kent. Bred Dec. 1928.

Patches of the colour of the uppersides of the hind-wings are reproduced almost symmetrically on the undersides of both hind-wings. On the right hind-wing in the cell bounded by 5 and 6 bright tawny scales occupy almost all the space between the dark marking at the proximal end of the cell and the ocellus, but do not encroach on the transverse grey line. They reappear distally in the posterior part of the cell near the lunule and in the middle at the margin of the wing. In the cell bounded by 6 and 7 there is a streak of the same colour replacing part of the central transverse bar and a large patch between this bar and the ocellus. On the left hind-wing in the cell bounded by 5 and 6 similar scales occupy nearly all the space between the dark mark at the proximal end of the cell and the ocellus, and the posterior two-thirds of the cell between the ocellus and the lunule, and the whole of the margin distal to the lunule. The distal part of the white ring of the ocellus and the posterior half of the lunule are obliterated. Between 6 and 7 the posterior three-quarters of the proximal part of the dark bar and most of the space between the bar and the ocellus are occupied by the same bright tawny scales, some of which replace part of the ocellus itself. There are more of these scales at the margin of the wing. Between 7 and 8 there is another streak distal to the dark central shading and extending into the shaded area in the line of the ocelli, and there are a few at the margin. Between 2 and 3 there are a few similar scales just distal to the ocellus. On either side of 7 the scales are much blacker than on the opposite wing and correspond with those on the upperside. The underside is rather dark and grey so that the tawny scales contrast sharply with the prevailing colour. There is no alteration in size and no crippling, and the upperside is normal. The tawny scales correspond in position with those on the upperside except between 7 and 8, but I think there is little doubt that it is an example of homoeosis. It differs very much from the other homoeotic *cardui*, which had the colour and pattern of part of the underside of the left fore-wing reproduced on the underside of the left hind-wing.

***Plebeius argus*, L.**

H. A. Leeds, Kent, 8.vii.1929.

Part of the pattern of the under surface of the right hind-wing is reproduced on the upper surface. The female is a brown one. Between 1 and 2 there is a pale blue speck just internal to the orange lunule; between 2 and 3 in the anterior half of the cell is a larger streak of similar colour; between 3 and 4 is a V-shaped mark with the apex pointing to the base of the wing, and nearer 4 a small streak of very pale blue scales both lying internal to the orange lunules. These marks represent the wedges of white scales that run inwards from the black crescents that lie just internal to the orange lunules of the under surface. The neuration, size, expansion, and under surface of the wing are all normal.

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PART II. EXTRA WINGS.

In *Trans. Ent. Soc. Lond.* for the year 1927 I reviewed the subject of extra wings in Lepidoptera and described some new examples. Since that date I have been fortunate enough to receive three more, a *Teracolus ithonus* from Mr. W. F. H. Rosenberg, an *Orgyia gonostigma* from Mr. A. E. Tonge, and a *Xanthia citrigo* from Mr. E. P. Wiltshire, and take this opportunity of thanking them for their generous gifts. Dr. Karl Jordan has allowed me to examine the *Charaxes antamboulon* in the Tring Museum, and Mr. J. J. F. X. King the *Oeonistis quadra* in the Glasgow Museum. Professor T. Bainbrigge Fletcher has given me a reference to an *Autosticha exemplaris*, Meyr. (GELECHIIDÆ), with two small hind-wings on the right side, which was presented some years ago to the British Museum, but has unfortunately been mislaid. I have also found a description of an *Argynnis paphia*, which I had overlooked. This makes an addition of six to the fifty-nine recorded two years ago.

The *Orgyia* seems to be a clear case of simple duplicity, the rarest type of extra wing, placed in Group I in my previous paper. The *Xanthia* falls into Group II *c*, the extra wing being a mirror image of the original wing and lying above it. The *Teracolus*, *Charaxes*, and *Oeonistis* appear to be in accord with Bateson's Law, though all exhibit unusual features and differ in some respects from any described before. In the *Oeonistis* the presence of two patagia as well as two extra wings is unique. All fall into Group III *b*, with the extra wings behind the original wing, and in all it is the fore-wing that is abnormal. The *Autosticha* may also agree with Bateson's Law, the little extra hind-wing being a double one, but this is merely conjecture and for the present it must be placed with the unclassified cases.

Cappe de Baillon has recently brought forward evidence derived from his study of double monsters in PHASMIDÆ, which makes it almost certain that all the examples of Lepidoptera with simple duplicity are double monsters, and pre-

sumably like the Phasmids they are formed in eggs with two micropyles. Bateson was puzzled by regeneration in wings being apparently different from that in all the other appendages. He believed, though wrongly, that all the recorded examples of extra wings showed simple duplicity. It has become increasingly clear that wings often follow the same law as the other appendages, but there seemed to be no reason why they should sometimes be regenerated in one way and sometimes in another. This discovery makes it probable that all the exceptions to Bateson's Law arise in a totally different way and are not due to regeneration at all, but are imperfect double monsters. Thus the examples placed in Group I in my first paper and the *Orgyia* are most likely double monsters.

Those placed in Group II may be due to local injury with regeneration, but with suppression of one of the extra wings, or they may be due to double monsters. Perhaps some originate in the one way and some in the other. I am inclined to think the *Xanthia* is a double monster, because the original hind-wing is not reduced in size, and when there is regeneration the original and the extra wings are all smaller than the corresponding wing on the opposite side. The fact that the extra wing arises from a different base and moves independently is not so important, because two extra wings in secondary symmetry, and therefore almost certainly regenerated, may have a base separate from that of the original. Some of the unclassified cases may also be double monsters. Cappe de Baillon's work has even thrown doubt on one or two specimens placed with some hesitation amongst those apparently conforming with Bateson's Law and the *Charaxes* described in this paper is one of them.

Orgyia gonostigma, Fab. ♂.

A. E. Tonge, Lincolnshire. Bred July 1927.

The specimen emerged during the holidays, and being left too long in the killing bottle the wings on the right side became inseparably stuck together. The wings on the left side, which are perfectly expanded and normal in all respects, were uninjured. The unfortunate accident has made it impossible to examine the insect fully. On the right side there are two fore-wings and a hind-wing, all of which appear to have expanded completely. The anterior fore-wing arises from the usual position and is exactly like the fore-wing of the opposite side in size, shape, and pattern. The posterior fore-wing has been damaged considerably in attempts to separate it from its fellow and from the hind-wing. So far as can be seen it was normal in all respects, its shape and size being the same as those of the anterior one. It springs from the thorax at a slightly higher level than the anterior one and from a point only a short distance behind, so that its costal margin overlies the subcostal nervure of the anterior wing. The neuration of both fore-wings appears to be complete, and both seem to be quite independent of one another. The hind-wing is folded a little, but was probably normal in every way. This appears to be an example of simple duplicity. The fact that both the right fore-wings are equal in size to the left fore-wing is very much in favour of this. In every case where there are extra wings, which follow Bateson's Law, the original wing and the extra wings are all smaller than the wing of the opposite side.

Xanthia citrargo, L. ♀.

Bred from a larva found on the Gog-Magog Hills, Cambridge, by E. P. Wiltshire, 1929.

There is an extra wing on the right side, in shape and scaling like a hind-wing with the under surface uppermost. A red-brown band runs transversely between the disc and the margin, and there are scattered scales of similar colour between the band and the termen.

These markings are not present on the upperside of a normal hind-wing but are present on the underside. The extra wing springs from a point above and behind the original hind-wing and can be moved independently. It is smaller than the original wing, 7.25 mm. $\times$ 4 mm., and its neuration is deficient. Nervure 1 is present, a discoidal cell with three nervures arising from it, two of which may be 3 and 4 and one of which is 7, and 8. The original hind-wing is normal in size, position, and neuration, but unfortunately a piece stuck to the setting-board and was broken off. A diagram of the neuration appears on Plate XIII, fig. 3, and a photograph of the moth on Plate XII, fig. 1.

Oeonistis quadra, L. ♀.

J. J. F. X. King, Glasgow Museum. Bred New Forest.

There is an extra patagium arising from the prothorax and two extra wings arising from the mesothorax on the left side, a combination of extra appendages that is, so far as I know, unique.

The original left fore-wing (L) is a little crumpled at the tip and slightly smaller than the right, 20 mm. $\times$ 7.25 mm. compared with 22 mm. $\times$ 7.25 mm. It has the usual neuration and markings; a fold of membrane looking superficially like a nervure runs between 1 and 2. Arising from a point a little above and posterior to it are two very imperfectly developed extra wings. They have a common base and cannot be moved independently of one another, though they can be moved independently of the original fore-wing. The first extra wing (R') is very small, 7 mm. $\times$ 2.5 mm., and fully expanded, but appears to have no nervures and has only the costal member of the pair of black spots found on a normal wing. The wing points upwards and backwards and its costa lies on the inner side, so that structurally it is like a right fore-wing. The second extra wing (L') is hardly recognisable as a wing. There is an anterior sharp edge of bare chitin bent back on itself, probably the costa, and to its inner and posterior aspect is a shapeless knob partly covered with yellow and partly with black scales. The base of the first extra wing looks rather like a patagium, that of the second like a little cushion lies anteriorly and a little internal to it. In spite of their poor development there is little doubt that the extra wings are in secondary symmetry with one another and conform with Bateson's Law.

Two patagia arise from the left side of the prothorax each having a separate origin and moving independently of one another. I can see no trace of a third patagium, which is presumably suppressed. The two that are present are well developed and of equal size, though rather smaller than that on the right side, and they have the usual long cilia, but it cannot be determined which is the original and which the extra one or whether they are both structurally like left-sided patagia or not. (Plate XIII, fig. 1, $\times$ 6.)

Teracolus ithonus, Butl. ♀.

Johannesburg.

The wings on the left side are normal, but springing from an independent base behind the right fore-wing is an extra wing. The original right fore-wing is very narrow, measuring 20 $\times$ 8 mm. instead of 22.5 $\times$ 15 mm. A piece of the costa is chipped out, but fortunately no nervure is injured. Nervure 6 is missing and there is no orange spot between 8 and 9. There is only one nervure posterior to the discal spot, but since the pattern between it and 5 is like that between 4 and 5 in a normal wing, I think it should be regarded as 4. If so 1, 2, and 3 are missing. The discal spot is much enlarged on the upper surface, but of the usual size on the under surface. The extra wing measures only 14 $\times$ 5 mm. and has three nervures. The pattern is like that of the missing part of the fore-wing, but cannot be regarded as such, because both the anterior and posterior or inner margins are ciliated. It is probably a fused double wing with all except the posterior parts of each

suppressed, and the nervure lying posteriorly is nervure 1 of the second extra wing, the two anterior ones being a branched nervure 1 belonging to the first extra wing.

The hind-wing is reduced in all dimensions and the neurulation and pattern are abnormal. Nervure 2 springs from the median at a point much too near the base and is double for a short part of its course. There is a small piece of an extra nervure between 2 and 3, and it has dark scales along it like the other nervures. Nervure 4 separates for a short distance into two parts, then joins again, and then branches into two distinct nervures which reach the margin. Nervure 6 ends before reaching the margin. The disco-cellular nervure is also situated rather nearer to the base than is normal. The figure shows the abnormality of pattern on the upperside better than any description. The underside of the fore-wing has a very similar arrangement of pattern though the discal spot is not enlarged as it is on the upperside.

Charaxes antamboulou, Lucas.

Madagascar. Tring Museum.

The left fore-wing is a little smaller than the right. Arising behind and slightly below it is an extra wing, perfectly expanded and exactly like the posterior part of the fore-wing. There is only one nervure, nervure 1, and at the base of the wing this nervure for a short distance forms the anterior margin of the extra wing. Further out there is a narrow strip of membrane in front of it and towards the termen a much wider strip. The distal portion of the extra wing is just wide enough to show the posterior part of the last marginal and submarginal spots. The wing though very narrow is of the same length as the corresponding part of the original fore-wing. Above the original wing is a large irregular mass of chitin, which looks like another wing base. Owing to its position and irregularity I cannot determine whether it is really like a right wing-base or not, but a portion of it appears to be exactly like that part of a normal wing-base from which nervure 1 springs, and as this portion is the most anterior part of the mass it may well be structurally a right wing-base. If so it is probably the only part of the first extra wing that has developed, while the narrow extra wing is an incomplete second extra wing. I offer the following explanation, which is in accordance with Bateson's Law. The base of the first extra wing, a mirror image of that of the original wing, has been displaced upwards and forwards and the wing itself has been completely suppressed. The second extra wing, a mirror image of the first, and so structurally a left wing, has been partially suppressed, only its posterior part having developed, and its base has been partially suppressed and pushed downwards. The alternative explanation is that the mass of chitin and the extra wing form part of a second individual, and that the whole is a double monster.

Argynnis paphia, L.

Oskar Schultz.

On the anterior border of the left fore-wing there is developed an accessory wing-structure, which, arising from the base, ends in a normal apex showing the usual pattern of the apical part. The anterior border of the wing-segment does not, however, quite reach the apex of the left fore-wing to which it is attached in a reverse direction; inasmuch as the anterior border of the left fore-wing extends about 2 mm. beyond the extreme end of the supernumerary wing-segment. This accessory segment is about 5 mm. wide. The pattern of the apical part (black spotted border) is clearly reproduced on its appendage; the black nervures are equally well marked. Nervures and pattern are as clear on the under as on the upper surface.

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EXPLANATION OF PLATES XI-XIII.

PLATE XI. HOMOEOSIS.

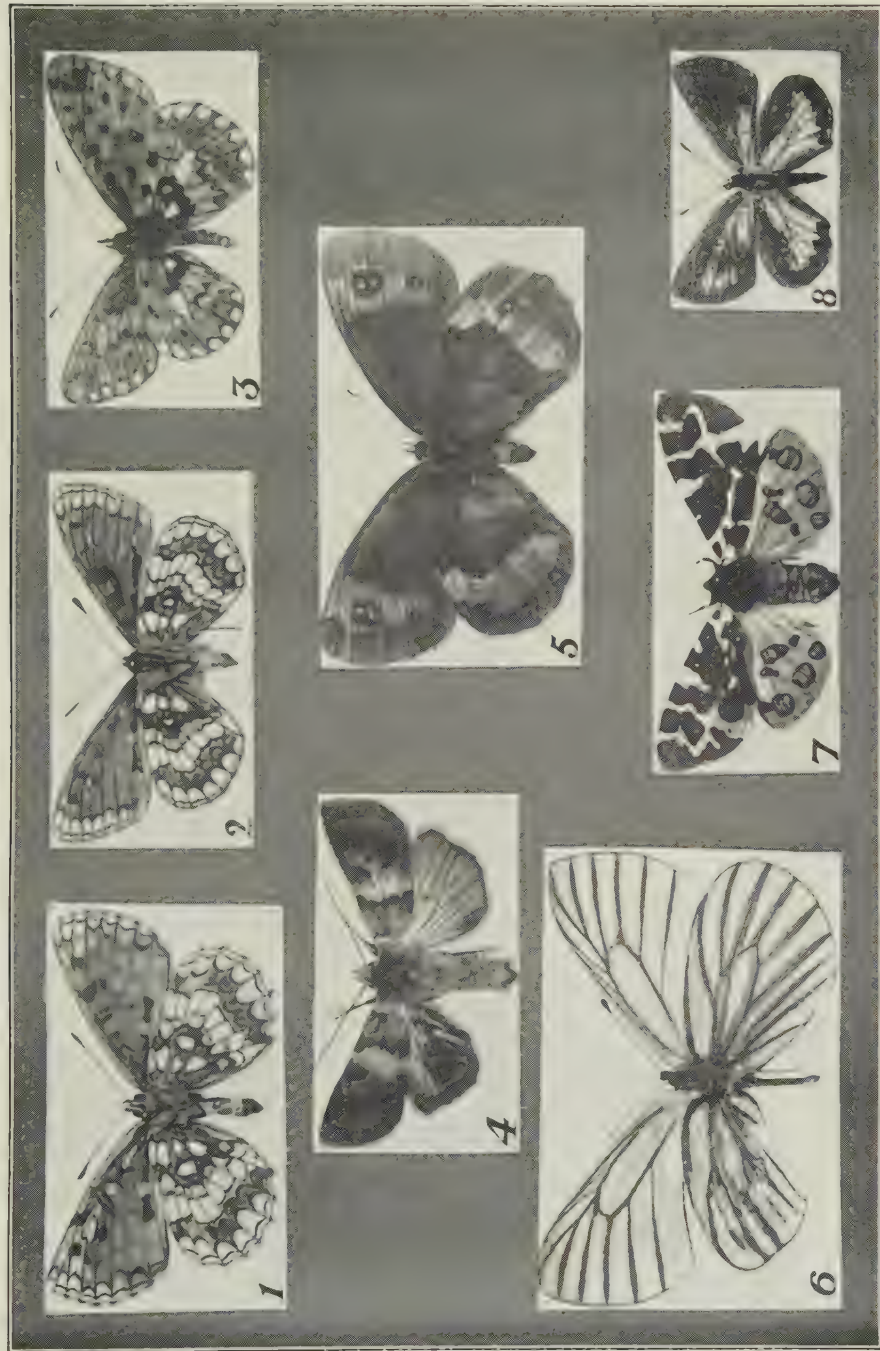
- FIG. 1. *Melitaea athalia*. Female. W. Crocker.
2. *Melitaea varia*.
3. *Brenthis euphrosyne*.
4. *Noctua festiva (primulae)*.
5. *Erebia aethiops* f. *derufata*.
6. *Pieris davidis*.
7. *Arctia caia*.
8. *Plebeius argus*.

PLATE XII.

- FIG. 1. *Xanthia citrigo* (extra hind-wing).
2. *Teracolus ithonus* (extra fore-wing).
3. *Charaxes antamboulou* (extra fore-wing).
4. *Aglais urticae* (homoeosis).
5. *Semiothisa notata* (homoeosis).

PLATE XIII.

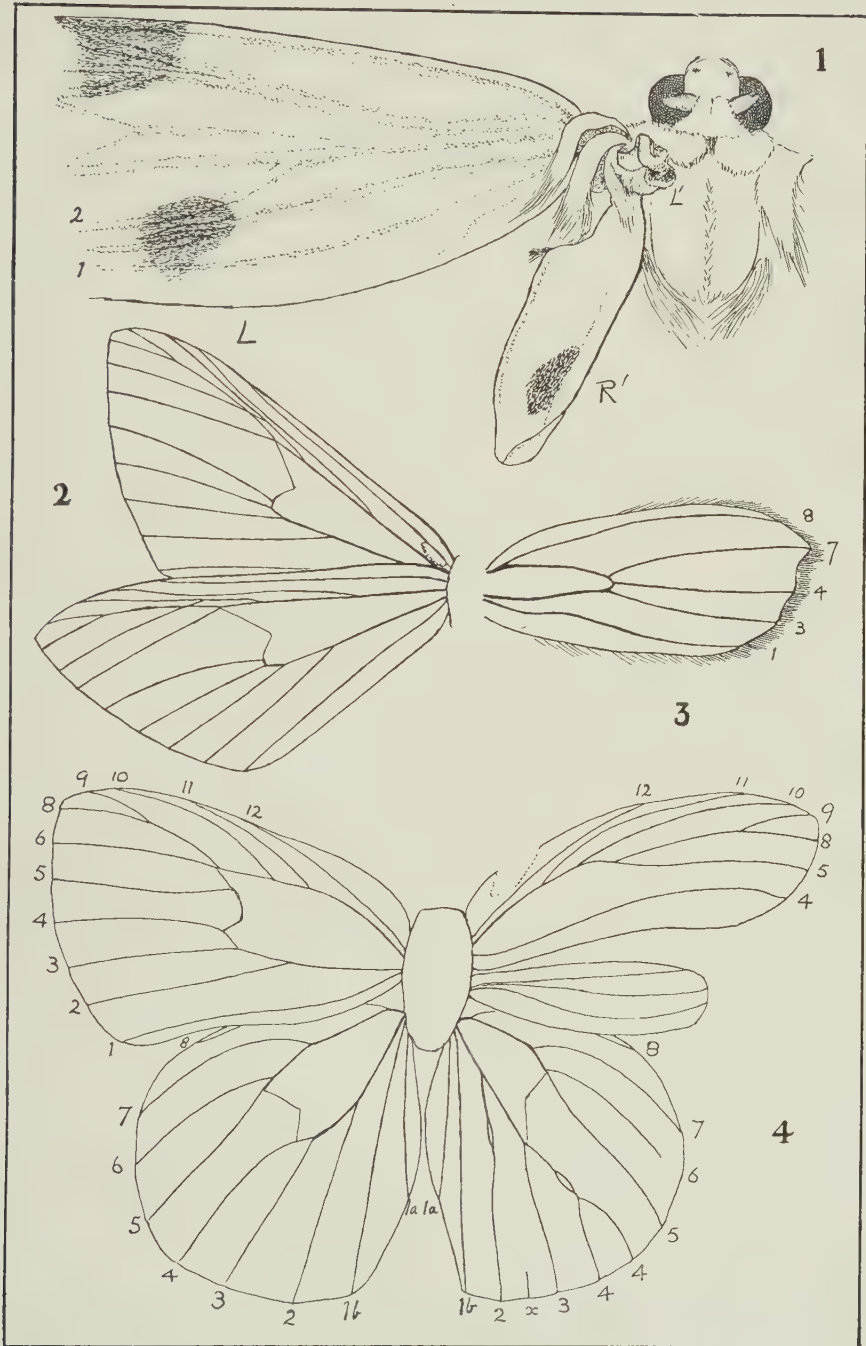
- FIG. 1. *Oeonistis quadra* (extra patagium and two extra fore-wings).
2. Neuration of *Orgyia gonostigma* (extra fore-wing).
3. Neuration of extra hind-wing of *Xanthia citrigo*.
4. Neuration of *Teracolus ithonus*.



EXAMPLES OF TERATOLOGY IN LEPIDOPTERA.



EXAMPLES OF TERATOLOGY IN LEPIDOPTERA.



EXAMPLES OF TERATOLOGY IN LEPIDOPTERA.

THE BIOLOGY OF A BLOOD-SUCKING BUG, *RHODNIUS PROLIXUS*

By P. A. BUXTON, M.A.

(London School of Hygiene and Tropical Medicine.)

[Read June, 4th, 1930.]

WITH ONE TEXT-FIGURE.

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INTRODUCTORY.

THE blood-sucking REDUVIIDAE (*Rhodnius*, *Triatoma*) are so easy to rear and to maintain in the laboratory, and so large, that they are certain to be used for studies in the digestion of blood, and in the physiology of a blood-sucking insect; but this cannot be done until careful quantitative data have been published relating to their normal life-cycle. For this reason the work here published was commenced, and from it has grown the investigation into the exact relation between sucking blood, sexual maturity and oviposition in these insects.

The work has been carried out with a strain of *Rhodnius prolixus*, which has been in captivity for at least ten years; it was originally sent to this institution by Prof. E. Brumpt.

In undertaking this work, full use has been made of the papers by Pinto, Brumpt, Larrousse and Uribe, but I have thought it best to repeat all the experiments, especially as I desired quantitative data wherever possible.

With regard to methods, all breeding has been done at 23–24° C., except where the contrary is stated. The humidity has not been accurately controlled, but it is essential to keep the insects in a moist atmosphere; as Larrousse has already stated, the eggs are liable to dry up unless pans of water are kept in the incubator. Insects were fed at room temperature. It is convenient to use a lop-eared rabbit; if only a few bugs are to be fed, and particularly if they are small, they can be put in a short wide tube, the mouth of which is covered with gauze, and attached to the ear of the rabbit by an elastic garter. If many bugs are to be fed, or if they are large, they may be put in a jampot, into which the ear of the rabbit is introduced; the mouth of the pot and the folds of the ear are then packed with cotton wool. The rabbit will sit quietly at the bottom of a box, 7 inches wide by 15 inches long; this gives it room enough for meditation, but none for exercise. It appears that the rabbit does not feel the puncture, and it gets no subsequent reaction. We have a rabbit on which dozens of bugs have been fed every week for more than a year, and on which we have sometimes fed more than a hundred in a day; but its ears are neither

red nor thickened. Occasionally the insects have been fed upon a guinea pig, but in most ways the rabbit is the more convenient.

THE EGG.

The distribution of the eggs in batches, and the relation of egg-laying to feeding are dealt with below (page 231).

The duration of the egg stage at 24° C. is extremely variable, and I am not able to explain the great differences which occur. I have records of 318 eggs, which were laid and kept at this temperature, and of which the length of the egg stage is known to within one day. In a single case the larva emerged on the 10th day, and at the other end of the scale was a single emergence on the 37th day; no other larva emerged later than the 24th day; remarkable though this is, the fact is beyond doubt. The majority of the eggs hatched either between the 14th and 16th days, or the 20th and 22nd days. In many instances, a number of eggs all laid on one day by a single female hatched in an irregular manner, and I feel convinced that the differences are due neither to temperature nor to humidity. The matter would well repay fuller study, and I merely draw attention to something which is clearly interesting and anomalous.

The eggs are generally attached to the blotting-paper on which the insects live, and the attachment is so firm that they cannot be removed without injury. Occasionally, under conditions which I cannot explain, eggs are laid loose, like those of *Triatoma* spp.

If the eggs are kept at 24° C. in a damp atmosphere, the proportion which fail to hatch is very low. I have notes of 1021 eggs, of which 835 hatched (82%). I feel little doubt that if particular care were taken, and if the optimum humidity were known and employed, a higher percentage of hatches could be obtained; but 80%, regarded as an approximation, is of considerable value, and any figure much below it would appear to indicate that conditions are unfavourable.

The percentage of eggs which hatch in successive batches is shown in the accompanying figures (Experiment 1).

Batch.	Number of eggs.	Number hatched.	Percentage hatched.
First	188	142	76
Second	335	262	78
Third	95	61	64
Fourth	62	42	68
Fifth	79	75	95
Sixth	111	107	96
Seventh	65	65	100
Eighth	86	81	94
Ninth	No record		
Total	1021	835	82

From these figures it would seem that there is a consistent rise in the proportion of eggs which are fertile; but this rise is probably due to increased skill on our part, and not to any inherent difference between the batches of eggs. Failure to hatch is, I think, generally due to the eggs becoming too dry. Grossly malformed eggs, similar to those sometimes laid by *Cimex*, are never produced by *Rhodnius*.

THE LARVA.

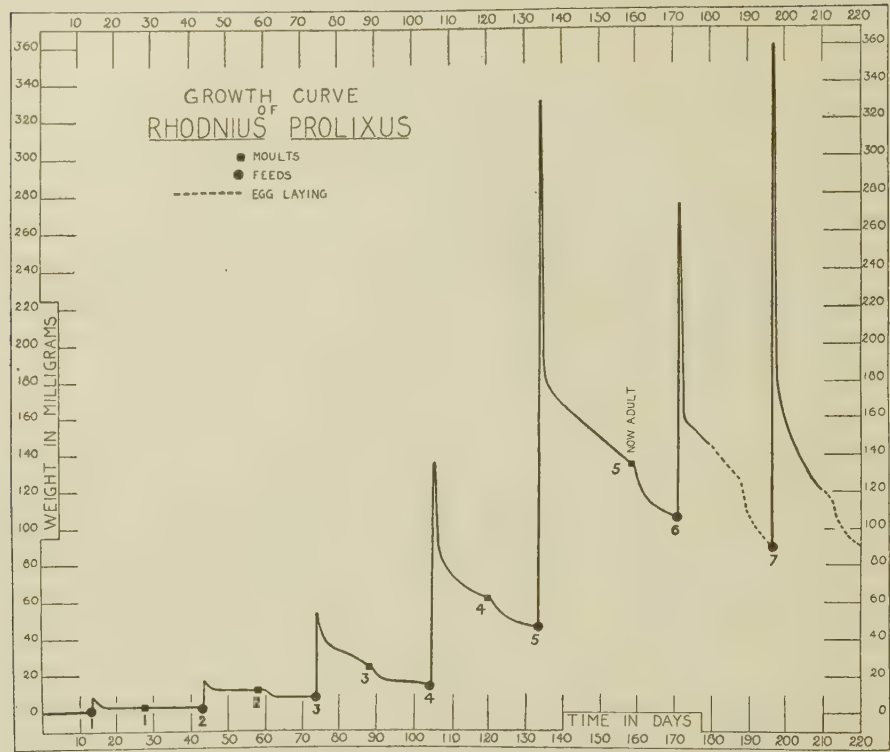
The life-cycle of a group of larvae was followed at 24° C. A number of larvae were taken (Experiment 2) which were known to be less than 24 hours old (day 0). They refused to suck blood at first, but fed from the 5th to the 8th day. The actual feeding, on this and subsequent occasions, occupies no more than a few minutes. The first ecdysis occurred from the 12th to the 15th day. The second feed, 16th to 18th day; second ecdysis 26th day. Third feed 30th to 35th day; third ecdysis 42nd to 46th day. Fourth feed 57th day; fourth ecdysis 72nd day. Fifth feed 77th day; fifth and last ecdysis 99th day. It will be observed that a single feed is, in each case, sufficient for one ecdysis. Frequently, however, it happens that an individual fails to secure a sufficient amount of blood at a feed, and does not moult when the others do. Such individuals are neglected in the facts given above.

Similar facts were accumulated for another group of larvae (Experiment 3) kept at 30° C., as follows. First feed 3rd day; first ecdysis 8th day. Second feed 14th day; second ecdysis 22nd day. Third feed 26th day; third ecdysis 35th to 36th day. Fourth feed 40th day; fourth ecdysis 49th to 51st day. Fifth feed 56th to 58th day; fifth and last ecdysis 72nd day.

The above facts relating to the duration of larval life at 24° C. and 30° C. must be taken as approximate only. I am certain that the duration of life at each temperature could be shortened if care were taken to offer blood to the larvae as soon after each moult as they were willing to feed. On the other hand, the period I have quoted is materially shorter than those quoted by either Larrousse or Uribe. So far as I observed, the number of larval stages is invariably five, and this is consistent with the results obtained by Larrousse; but my work was done with a considerable number of larvae in a tube, so that it is possible that if the life of isolated larvae were followed, it would be found that the number of stages was variable.

A couple of days after the insects were fed, they were transferred to clean tubes and blotting-paper. No diseases were ever observed among the larvae, and the only cause of death known to me is incomplete moult and the incarceration of the proboscis or legs in the remains of the unmoulted skin. It may be remarked that if larvae are kept at room temperature (about 16° to 18° C.) they are able to feed and to digest blood, but that a great mortality occurs owing to failure to escape from the old skin at moulting.

My colleague, Dr. V. B. Wigglesworth, has studied the amount of blood taken at successive meals, and the increase in weight of the larvae, instar by instar; he has been so good as to allow me to include his facts, which are set forth in Table I. The weights quoted in the table are means derived from two batches of larvae. The two batches consisted originally of 28 and 33 individuals respectively, but at each feed only those which had fed well were selected for weighing; the remaining larvae, many of which would have required to feed twice in a given instar, were rejected. Similar facts, relating to another group of larvae, are shown in figure 1, drawn for me by Mr. H. S. Leeson. The table and figure are self-explanatory. I will only call attention to the extraordinary weight of blood which the insect is able to imbibe, often within a few minutes; and to the rapid elimination of some part of the blood in the day or two which succeed feeding. Titschak has published a similar curve for the growth of *Cimex*.



TEXT-FIG. 1.—Growth in weight of *Rhodnius prolixus*; the figures are means, derived from a group of larvae.

TABLE I.

SHOWING MEAN WEIGHT OF LARVA OF *Rhodnius prolixus*, SHORTLY AFTER EACH ECDYSIS; WEIGHT OF BLOOD TAKEN AT EACH FEED; AND RATIO OF WEIGHT OF BLOOD TO WEIGHT OF INSECT. FIGURES FOR TWO BATCHES OF LARVAE ARE GIVEN SEPARATELY.

INSTAR.	BATCH I.			BATCH II.		
	Weight unfed, mg.	Weight of blood taken, mg.	Ratio.	Weight unfed, mg.	Weight of blood taken, mg.	Ratio.
I.	0.5	5.9	11.8	0.445	5.63	12.5
II.	2.4	15.8	6.6	2.1	14.7	7.0
III.	6.9	48.7	7.1	5.9	38.3	6.5
IV.	18.1	118.5	6.55	15.7	108.0	6.9
V.	47.4	284.2	6.0	46.7	274.0	5.8
VI.	104.0	172.0	1.65	94.0	147.0	1.56

THE ADULT.

The mean weight of adults, known to be less than 24 hours old, is 83.3 mg. for males (nine individuals), and 103.5 mg. for females (eleven individuals). I have no data relating to the normal range of weight of individuals of either

sex. If adults are kept fasting, they lose weight gradually owing to metabolism; there is also a slight irregular loss of weight owing to the deposition of faeces, and this continues up till at least the eleventh day after the insect has become adult, in spite of the fact that it has had no food since it was in the last larval instar. A small number of freshly emerged adults were starved completely, at 24° C., in a damp incubator (Experiment 4). Seven males lived between 30 and 60 days, the mean duration of life being 41 days; for 9 females the extremes were 30 and 40 days, and the mean 35 days. I think that there is no significant difference between the sexes in this respect.

We do not know how long the insects will live if they are given one feed after maturity, and then starved.

Normally, of course, the adults feed, and if this occurs the sequence of events is as follows. It will be remembered that adults were obtained at 24° C. on the 99th day after emergence from the egg (Experiment 2, page 229). It will be convenient to renumber the days from this point, and to start with the newly emerged adult on day 0 (Experiment 5). The insects refuse blood on days 1 and 2, and frequently on day 3. But many individuals feed, and feed well, on day 3, or day 4 at latest. The weight of blood taken at the meal is shown in Table I. It will be observed that adults take relatively a much less quantity than larva, but it is sufficient to distend them greatly, and to cause the male organs to herniate out of the body. On one occasion a female was feeding on a rabbit's ear, and she pumped herself full of blood, and burst; this was entirely due to the efficiency of her pumping mechanism, and not to any treatment from us. If males and females have been kept together the first egg is laid on or about day 13.*

Egg laying was studied in several tubes, in each of which a male and several females were kept together (Experiment 6). In each tube, eggs were collected daily, and when egg laying had ceased for several days, the insects were again allowed to feed. Under these circumstances feeding took place at intervals of a little less than a month, each feed leading to the production of one batch of eggs. The following facts were collected.

Batch.	Number of eggs.	Number of females.	Eggs per female.
First	447	12	37.2
Second	484	11	44.0
Third	249	11	22.6
Fourth	468	11	42.5
Fifth	147	7	21.0
Sixth	178	6	29.7
Seventh	120	5	24.0
Eighth	123	4	30.7
Ninth	26	1	26.0

These figures reveal several facts of interest. Apart from one which was accidentally killed after laying only a single batch of eggs, all the females laid at least four batches. After that individuals died, and at each successive batch the number of surviving females is less. Only one female out of eleven laid a ninth batch of eggs. The mean of the values in the last column is 30.9,

* The insects which had been bred at 30° C. moulted for the last time on the 72nd day. They fed three days later, and six days after that laid their first eggs, that is to say nine days after becoming adult.

and the divergences from this figure in successive batches do not appear to show any consistent rise or fall in the number of eggs per female. The amount of irregularity in the figures in the last column is great, particularly when it is remembered that these figures are means based on the egg-production of a number of females. It would be of interest to repeat the work, using a large number of isolated pairs, and recording the eggs of each separately. It is only by doing this that satisfactory evidence relating to the number of eggs in successive batches, and the "scatter" in the number per female, could be obtained.

The above facts (Experiment 6) were collected from tubes containing a male and several females. I have no information regarding the total number of eggs laid by a single female. Uribe gives the total as 200–300 eggs.

I have not determined the number of females which may be successively fertilised by a single male. In one experiment (Experiment 7) one male and seven females were kept together, and out of 390 eggs (of several different batches) 351 (90%) hatched. This figure indicates that the single male was capable of fertilising at least seven females.

A little work was done to discover for what period a female could remain fertile after pairing, if the male were removed (Experiment 8). Pairs of insects were fed and kept together, until the female had finished depositing a batch of eggs. The males were then removed, and the females fed again. Five such females laid 128 eggs, 104 of which produced larvae, and the eggs of each individual female were shown to be fertile. The percentage hatch (81%) is normal, and one concludes that a female which has been fertilised remains fertile for at least one succeeding batch of eggs after the removal of the male. Whether she is fertilised for life I do not know.

I have very few facts relating to the duration of life of adults, when they were fed at the completion of each batch of eggs : three males died on the 156th, 160th and 167th day ; eight females on the 127th, 133rd, 154th, 169th, 189th (twice), 203rd and 207th day (mean 171 days).* None of the above deaths were due to accident or any ascertained cause. I think that they may fairly be attributed to old age, and in the females to exhaustion, following the laying of the eggs. In support of this view nearly all females died after completing a batch of eggs, generally within a couple of days of so doing. It would be interesting to feed females once a week ; it is possible that they would lay their quota of eggs in a shorter period, and die at an earlier date.

So far I have dealt with the normal life-history of the adult, the sexes being kept permanently together and fed when they required it. I shall now describe certain experiments, designed to investigate the precise relations between feeding, copulation and oviposition. In all these experiments I isolated single large larvae, so that when they became adult, it was certain that they were virgin. I then investigated what occurred when either the male or the female was allowed to feed. I first showed, by preliminary experiments, that if individuals are fed and then the proboscis is removed before they are brought together, normal pairing takes place. Three such pairs laid 122 eggs, of which 98 (80%) hatched ; each of the females laid fertile eggs ; the experiment was discontinued (Experiment 9). The presence of the proboscis is not therefore essential to copulation. Without this knowledge, one could not put an unfed male with a fed female, and observe the result, for the possibility would always occur that the unfed male had obtained food by piercing the female, or by coprophagy.

* These figures give the duration of life of the adult ; the duration of the early stages is not included.

Let us study first the case in which pairs are made up, neither male nor female having fed since the last moult (Experiment 10). Twelve such pairs were kept till death. Eleven laid no eggs; one female laid two unfertile eggs.

We will now take the case of the female, allowed to feed but kept in isolation without a mate. Ten virgin females were kept separate and fed (Experiment 11). The interval from the first feed to the first egg was two or three weeks, which is longer than usual; two of the females laid no eggs at all. The number of eggs laid in the first batch was from 34 to 0, and the mean 11.2 (normal is 37.2). A total of 307 eggs was collected, not one of which was fertile. (It is not implied that the ten females could lay only 307 eggs, for at this point the experiment was discontinued.) It is concluded that parthenogenesis is extremely rare, if it ever occurs, of which I have no evidence.

The purpose of the next experiment was to discover whether an unfed male was potent. Males deprived of the proboscis were used, it being known (Experiment 9) that such deprivation does not of itself prevent successful pairing. In each case the male, without proboscis, was put with a virgin female, and she was then allowed to feed (Experiment 12). This experiment was carried out eight times. On five of these occasions fertile eggs were laid in the first batch; of a total of 92 eggs, 72 were fertile. The mean number of eggs per female was therefore only 18.4 (normal 37.2), the highest and lowest figures 26 and 6. Of the remaining three females, two laid no eggs after the first feed, and the third 13 eggs, all of which shrivelled. From this experiment one concludes that an unfed male is not always potent, but that when successful pairing occurs, an unusually low number of eggs is laid in the first batch; the percentage fertility of the eggs is normal. This curious and interesting fact is discussed below.

If the male is fed and the female not, no eggs are laid; this might almost be predicted from Experiment 10.

Now let us see what happens if both individuals are fed, but if the normal time relations between feeding and pairing are interfered with. If the insects are free to behave as they wish, the normal relation appears to be that the insects feed and then pair; they frequently do so at once, often on the rabbit's ear; the reverse order has also been observed, but only in bugs which had fed about a month earlier. One naturally wonders whether pairing can precede feeding in bugs which have never fed. An experiment was performed with unfed virgin males and females, which were from 1 to 25 days old, at the start of the experiment; thirteen pairs were made up and in each they were kept together unfed for four days (Experiment 13), after which the males were removed and the females fed; the eggs were then collected, and the proportion which hatched recorded. The numbers of eggs in the first batches were 0 (4 times), 1, 4, 6, 7, 12, 17, 19, 20 and 28. Every egg in the batch of 20 hatched, and as I am convinced that no error in handling took place, we must conclude that occasionally a successful pairing can take place between bugs, neither of which have fed. With this noteworthy exception, no eggs hatched, so that we may say that the remaining twelve pairs produced 94 eggs, none of which hatched. Moreover, four females laid no eggs after their first feed, though three of them did so after a second feed (the fourth dying before the second feed). Furthermore, there were long delays of three and four weeks between the first feed and the beginning of egg-laying, in the case of those females which did lay. We may say, therefore, that in all respects these twelve females behaved like virgin, fed, females; pairing between unfed males and females is clearly rare, though it did occur on one occasion out of thirteen.

A converse experiment (Experiment 14) was then performed to discover whether pairing could occur if it were deferred till long after the bugs had fed. A male and female, bred and fed in isolation, were brought together three days after the feed; the female laid 20 eggs in the first batch, of which 17 hatched. A male and six females were then fed and kept separately, and all brought together seven days after feeding.* The females were isolated six days later. Two of them laid fertile eggs, after a fortnight's delay two laid eggs which were unfertile, and two laid no eggs at all. One may therefore say that two females had certainly paired, the remaining four not. A single male and female were then fed, and kept separate till 15 days later: the female laid 25 eggs, all of them fertile. From this set of experiments I conclude that pairing, if prevented for the first week or more after feeding, may occur, but that it is not invariable, as it is if pairing immediately after feeding is possible.

SUMMARY AND DISCUSSION.

The greater part of the paper, which relates to the normal life-history of *Rhodnius prolixus*, hardly requires to be summarised. One or two points of general interest emerge from it; I shall take this opportunity of contrasting *Rhodnius* with *Cimex*, the Bedbug, the biology of which has been so fully studied by Cragg (1923). The duration of the egg stage of *Rhodnius*, at a constant temperature, varies from 10 to 37 days; even if one takes the eggs laid by a single female on a particular day, emergence seems to be quite erratic. The growth of *Rhodnius* (see the table and figure) is dramatic. The larva generally feeds once in each instar, and feeding occupies only a few minutes; at its first feed it takes about twelve times its weight of blood, and even the last larval stage takes about six times; the adult takes about one and a half times its weight, and feeds about once a month. The sudden rise in weight is followed by a rapid fall, most of the water and certain other constituents of the blood being passed in the two days succeeding the meal.

We know very little of the causes of death. At least 80% of eggs hatch, and quite frequently the percentage is over 90% (Experiment 1). If larvae are overcrowded they drown in one another's liquid excrement, but I know no "normal" cause of death. Adults, provided they are fed, appear to die of old age, death in the female nearly always occurring just after a batch of eggs has been laid.

Successful pairing between individuals which have never fed as adults does not occur; † such females do not generally produce even an unfertile egg (Experiment 10); the unfed males are potent, with limitations which are discussed below (Experiment 12); the female which has fed and paired can lay at least one batch of eggs after she is separated from a male; this corresponds to a period of about a month (Experiment 8). In all the particulars mentioned above, *Rhodnius* resembles *Cimex*.

On the other hand, *Rhodnius* and *Cimex* differ in several respects; a female *Cimex* which has paired but is ill-nourished lays eggs which are evidently "imperfect," whereas the eggs of *Rhodnius* all appear identical irrespective of whether the female is well fed or whether she has or has not paired; virgin females of *Rhodnius* lay unfertile eggs, whereas those of *Cimex* lay no eggs at all, even if they feed repeatedly.

In other words, it has been shown that the relation between feeding and the sexual processes of *Rhodnius* is complex. For instance, a female which has

* We know that a male is capable of fertilising this number of females (Experiment 7).

† According to Cragg *Cimex* behaves similarly; but Jones' results were consistently different; his unfed females, kept at 27° C. and 75% humidity laid eggs.

never fed since she became adult cannot lay eggs (Experiment 10). If her virginity is safeguarded, and she is fed, she lays eggs which are always infertile; egg laying commences after an unusual delay; moreover such a female sometimes fails to lay eggs till she has been fed twice, which is abnormal, and even when she lays after the first feed, the number of eggs is less than a third of the normal (Experiment 11). One may therefore say that both food and copulation are necessary to the female if she is to lay a normal number of eggs, and do so without unusual delay.

In studying the male, we may begin with an unfed individual, from which the proboscis has been removed; such a male is put with a virgin female which is then allowed to feed. In three out of the eight occasions on which this was done, pairing did not take place. In the remaining five, pairing took place, and eggs were laid; the number of eggs in the first batch was about half the normal, but the proportion which were fertile was normal (Experiment 12). Here again the relation between feeding and the sexual life of *Rhodnius* is shown to be complex. It is evident that the unfed male does produce living spermatozoa, but it would seem that his nutritional state affects the female's capacity for producing eggs.

In this respect, I venture to think *Rhodnius* resembles *Cimex*, though the case of *Rhodnius* is certainly simpler and less extraordinary. In *Cimex*, eggs are never laid by unfertilised females; but the unfed female, after fertilisation, lays a few "imperfect" eggs. In this case, the act of copulation does not result in fertile eggs being laid, but it does cause the production of these "imperfect" eggs. Take now the case in which the female is fed, and paired with an unfed male; she lays eggs, and they are fertile, but they are below the normal in number. Cragg's comments on his own investigations upon *Cimex* are as follows:—

"The mass of spermatozoa injected by the male is relatively very large. The act of copulation is repeated very frequently during the breeding season, and there is thus a constant stream of spermatozoa passing from the organ of Berlese * to the ovarioles; in caught specimens it is usual to find spermatozoa in the organ of Berlese, in the body cavity—here often in masses so large that they can be picked up on the point of a needle in dissection—and in and attached to the spermathecae. . . . It is evident that we have to do with a problem of a general nature. It is unlikely that the case of *Cimex* is really unique, or that the spermatozoa of this insect are essentially different in nature or in function from those of other insects or of the higher animals. If in *Cimex* those spermatozoa which are not used up in the fertilisation of the eggs are disposed of in some way beneficial to the female, then that spermatozoa generally should have some such additional function is probable."

It seems clear that in *Rhodnius* and also in *Cimex*, the male which has fed does not merely transfer spermatozoa to the female but also something † essential to the production of a normal number of eggs (*Rhodnius*) or else of eggs which are perfect in appearance and also fertile (*Cimex*). In *Cimex* the case is

* In *Cimex*, there are two sexual apertures in the female. Eggs are laid through a median ventral one. Copulation occurs through a slit on the right side of the fifth sternite. The spermatozoa pass through a modified part of the intersegmental membrane, the organ of Ribaga, into a mass of cells, the organ of Berlese. They pass through this into the haemocoel, in which they may be found free; they then reach and penetrate the spermatheca, and travel up in the wall (not the lumen) of the oviduct to the developing eggs in the ovariole. This remarkable and probably unique event was described by Cragg (1920).

† It is possible that the "something" is simply an excess of spermatozoa, which are not used in the actual fertilisation of the eggs.

greatly complicated, both in anatomy and by the fact that copulation takes place very frequently.

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NEW EUROPEAN TRICHOPTERA AND PLECOPTERA

By MARTIN E. MOSELY.

[Read June 4th, 1930.]

PLATE XIV AND THIRTY-THREE TEXT-FIGURES.

DURING the past eight or nine years, excursions on the Continent, devoted almost exclusively to the collection of Trichoptera and Plecoptera, have resulted in the accumulation of a mass of material none of which has as yet been recorded. It is to be expected that when intensive collecting is made in little-known Orders, new species will no doubt turn up, and my own experience has proved no exception to this rule.

A trip to Corsica resulted in the discovery of twenty new Trichoptera and five Plecoptera, and the Trichoptera have already been considered in a paper published in *Eos*, Madrid, during the past year. The description of a new genus in the Trichoptera, discovered at Cagnes in the South of France, has appeared in the *Annals and Magazine of Natural History*.

There remain a few new continental and one new British species which I am describing here in order to clear the way for a complete record of these trips.

The new British species, a Hydroptilid, *Orthotrichia tragetti*, has been in my collection for some years and was found on a Hampshire lake. It was originally determined as *O. angustella*, McL., but Dr. Ulmer's recent paper, with its useful description and figures of this species, has made it clear that the Hampshire fly was wrongly placed. The British examples, two in number, were already mounted together in a balsam preparation and the parts were not very easy to make out, but the discovery of a third unmounted example amongst an overlooked little collection from St. Paul-de-Varax in France, has enabled me to give a description in this paper.

I have also taken the opportunity of including a description of the hitherto unknown male of *Apatania arctica*, Bohem.

TRICHOPTERA.

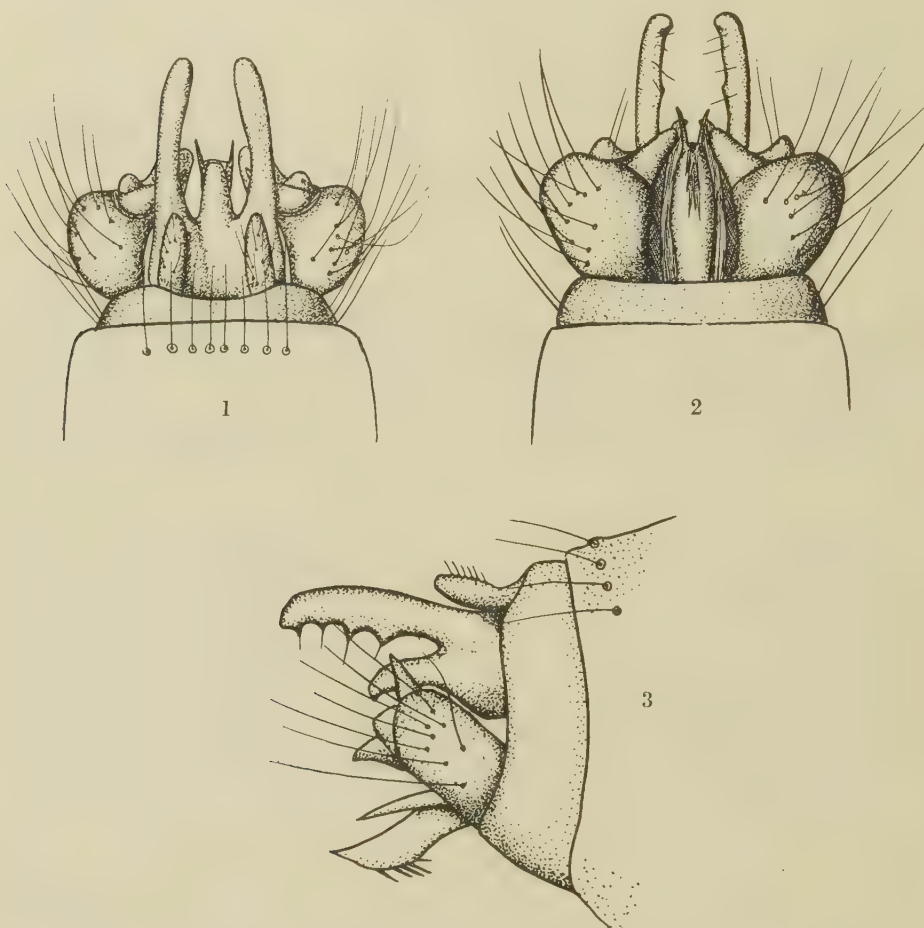
Family LIMNOPHILIDAE.

***Apatania arctica*, Bohem. Figs. 1-3.**

Apatania arctica, Bohem., together with *A. muliebris*, McL., have generally been regarded as examples of parthenogenesis. While the male of *muliebris* continues to be a desideratum, a male *arctica* was presented to me some years ago, included in a fairly long series of females from Ellidavatn in Iceland, taken in June 1922. The male differs somewhat in general appearance from the female, the pterostigmal area being heavily shaded; the expanse of wings is 20 mm. as against 18 mm. in the female. The genitalia very closely resemble those of *fimbriata*, Pict. but there are slight differences in the shape and proportion of the various parts which will be understood if the figures of the two

species are compared. The possibility cannot be dismissed that *arctica* may only be a local form of *fimbriata*.

Genitalia, ♂. Margin of last dorsal segment has a wide, shallow excision; superior appendages short, widely separate, overlying the bases of the intermediate appendages, upper margins seen from the side, serrate; intermediate appendages from above, finger-shaped, curving slightly towards each other; from the side, lower margin shows four



FIGS. 1-3.—*Apatania arctica*, Bohem. ♂. 1 genitalia dorsal, 2 ventral, 3 lateral.

strong teeth; upper penis-cover (median process) appears to be fused at the base with the intermediate appendages; seen from the side, it terminates in a down-curved hook; inferior appendages two-jointed, the first from above widely rounded, the second joint having three branches, the upper long and pointed, directed inward, the lowest, still larger with rounded apex also directed inward, whilst the third, which is the smallest, arises towards the inner edge of the joint and is directed outward, its apex forming a rounded projection between and outside the upper and lower branches; from beneath, the first joints are greatly dilated towards the apex, inner margins slightly concave, second

joints with the apices of the lowest branches approaching each other; penis broad, apex truncate, its outer margin produced in two thin vertical plates; seen from the side, there is, on the ventral surface towards the apex, a group of spines directed backwards; penis sheaths straight and yellowish.

Family LEPTOCERIDAE.

Leptocerus minor, sp. n., Fig. 4; *L. dissimilis*, Fig. 5.

In its outward appearance, this species closely resembles *L. dissimilis*,

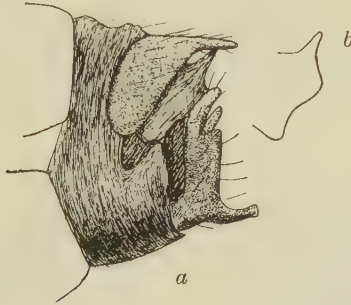


FIG. 4.—*Leptocerus minor*, sp. n. ♂. *a* genitalia lateral, *b* upper penis-cover.

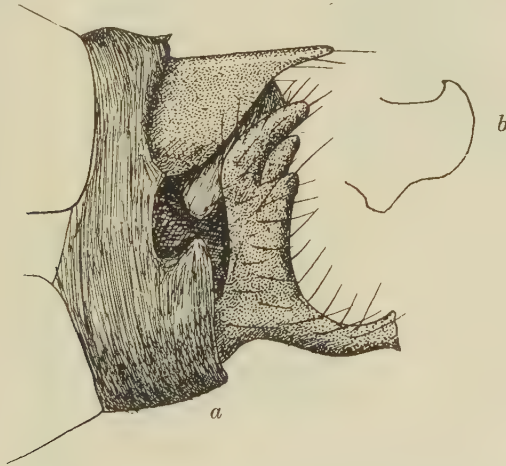


FIG. 5.—*Leptocerus dissimilis*, Stephens. ♂. *a* genitalia lateral, *b* upper penis-cover.

Steph., but differs slightly in the structure of the genitalia and in the smaller size of the male as compared with that of the female.

Genitalia, ♂. From the side, upper margin of last dorsal segment sinuate, and without the acute process seen in *dissimilis*; upper penis-cover broad, upper angle produced in a finger-like process directed upward and outward, the outer margin sinuate towards the apex (in *dissimilis*, of which a figure is given, the corresponding part is much broader and is curved upward and inward, the outer margin being convex towards the apex); lower

branch of inferior appendage shorter than in *dissimilis*, with outer margin angulate whilst in *dissimilis* it is evenly curved.

Length of body, ♂, 5 mm.; expanse, 15 mm.

„ „ „ ♀, 4 mm.; „ 12 mm.

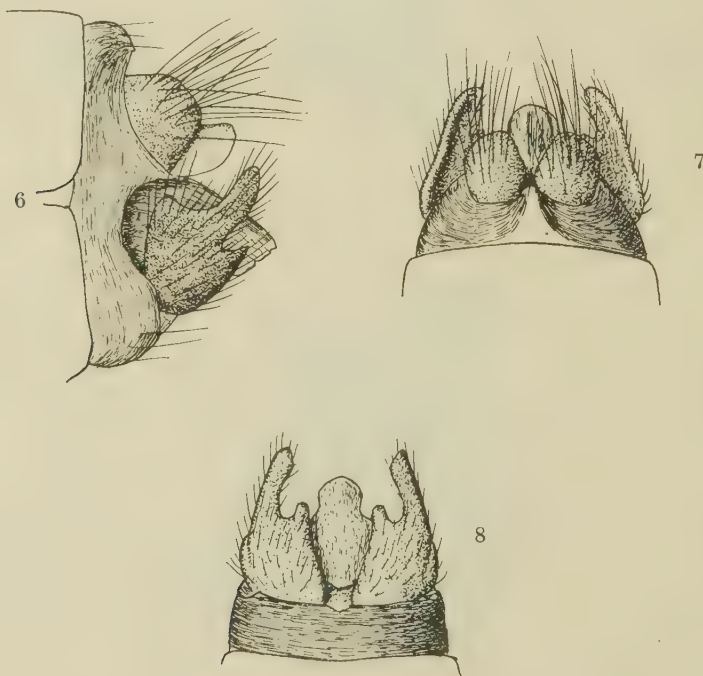
Type ♂ and paratypes ♀♀ in the author's collection.

France, Basses-Pyrénées, Itxassou, 19-27.vi.1929.

I have, in my collection from the River Lot, Cahors, France, two or three ♀♀ tentatively placed under *dissimilis*. Their small size suggests that they may belong rather to *minor*.

***Oecetis albescens*, sp. n. Figs. 6-8.**

Head clothed with pale ochraceous hairs; palpi, pale ochraceous; antennae still paler with no annulations.



FIGS. 6-8.—*Oecetis albescens*, sp. n. ♂. 6 genitalia lateral, 7 dorsal, 8 ventral.

Wings: Anterior, nearly white, with pale ochraceous pubescence, fringe darker; posterior, white, pubescence imperceptible, fringe, pale ochraceous. Neuration of both wings resembling that of *Oecetis ochracea*, Curt.

Legs, pale ochraceous, nearly white.

Abdomen, dark ochraceous above, paler beneath.

Genitalia, ♂. Last dorsal segment produced in centre to a short rounded lobe; superior appendages, from above, oval, lightly chitinated, clothed with long hairs; beneath them is a short membranous upper penis-cover; penis membranous, directed outward and slightly downward; lower penis-cover, from side, triangular, directed downward to acute apex; from beneath U-shaped, lower margin strongly chitinated; from the side, last

segment produced towards the centre in an acute angle; inferior appendages, from the side, tri-pointed, upper margin elbowing to make the first point, which is very obtuse, then extending in a wide curve to make the second, which, with rounded apex, is much the longest, finally by a narrow incision making a short third point with an acute apex; from beneath, appendages are wide at base, apex furcate, outer branch being the longer; margin of last ventral segment with a small excision at centre.

Length of body, ♂, $4\frac{1}{2}$ –5 mm.; expanse, 19–21 mm.

♀ unknown.

Type ♂ in the author's collection; paratypes ♂ in the author's and British Museum Collections.

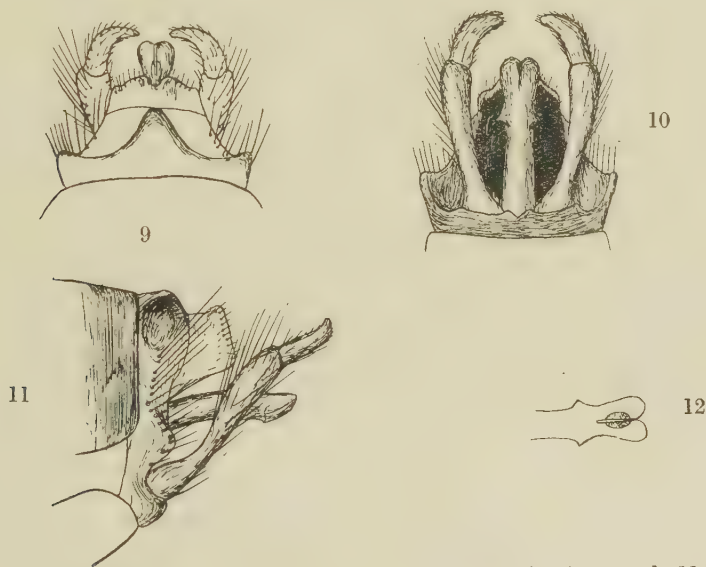
Switzerland, Rapperswil, L. Zurich, 7–15.ix.1926.

This species shows a close structural resemblance to *O. testacea*, Curt., which occurs in the same district at the same period. It differs slightly in the form of the genitalia, but principally in its pale colour, almost white, and its small size.

Family HYDROPSYCHIDAE.

Hydropsyche brevis, sp. n. Figs. 9–12.

Head, yellowish-fuscous, warts dark fuscous, clothed with cinereous hairs; palpi fuscous; antennae yellowish with dark oblique lines.



FIGS. 9–12.—*Hydropsyche brevis*, sp. n. ♂. 9 genitalia dorsal, 10 ventral, 11 lateral, 12 penis.

Wings, yellowish grey, clothed with short yellowish pubescence; on anterior is a dark streak, bordering nervure passing diagonally back from lower branch of cubitus to inferior cubitus towards base of wing; a dark spot on lower branch of cubitus at its junction with nervure connecting with margin of median cell; on lower margin of wing, a longish dark patch towards the middle and a fainter patch towards the apex, three dark spots at extremities of nervures bordering first two apical cellules along apical margin of wing; posterior wing uniformly yellowish grey.

Legs, light fuscous.

Abdomen, dark fuscous above, paler beneath.

Genitalia, ♂. Centre portion of dorsal plate, from above, very dark, extending rather more than halfway across plate; dorsal plate short, margin strongly chitinised, excised in centre of apex; from the side, nearly rectangular; penis terminating in two small lobes, strongly angulated before the apex; inferior appendage, from the side, with basal joint dilating gradually towards apex, terminal joint very short and broad, apex somewhat acute; margin of last ventral segment slightly excised.

♀ as is usual in the genus.

Length of body, ♂, 6 mm.; expanse, 21 mm.

" " " ♀, 5½ mm.; " 20 mm.

Type ♂ is a balsam preparation in the author's collection; paratypes ♂ and ♀ in author's and British Museum collections.

France, Basses-Pyrénées, St. Jean-Pied-de-Port, 28.vi-3.vii.1929.

This is a nicely-marked, light-coloured insect, resembling *instabilis*, Curt., superficially but without the two-jointed process which is characteristic of that species.

Family RHYACOPHILIDAE.

Rhyacophila martynovi, sp. n. Figs. 13-15.

Head, yellowish-fuscous, clothed with light fuscous hairs; oculi very black; palpi fuscous; antennae yellowish.

Wings, yellowish, rather broad but with acute tips; anterior, with dark grey shading in the form of the letter **W** stretching across wing from extreme base as far as middle of fork 1; dorsal blotch very large, contained within lower angles of the **W**; in fourth and fifth apical cellule are two greyish dots, remainder of wing closely marked with pale yellow irrorations; posterior, uniformly pale yellow.

Legs, pale fuscous.

Abdomen, very dark fuscous above, yellowish beneath.

Genitalia, ♂. Anal parts yellowish; centre process of dorsal plate narrow, longer than side valves, and paler in colour, apex slightly excised; seen from the side, there is a keel-shaped process beneath it extending beyond apex and connecting in a sweeping curve with upper penis-cover; upper penis-cover terminating in two clavate processes; penis from the side, short, inclining slightly upward, with a hook directed forward on the upper margin towards the apex; lower margin dilated in a keel-shaped process as in the *intermedia* group, upper margin widely dilated, serrate; from above, base of penis very wide, with outer margins turned upward, forming two obovate walls, upper margins serrate; penis-sheaths very long, straight, lying parallel with sides of penis and extending beyond it, apices furnished with two or three spines of which one is very long and stout; lower penis-cover membranous, enclosing base of penis and sheaths. Inferior appendages two-jointed, terminal joint widely excised to show a small upper fork.

♀ as is usual in the genus.

Length of body, ♂, 11 mm.; expanse, 31 mm.

" " " ♀, 13 mm.; " 32 mm.

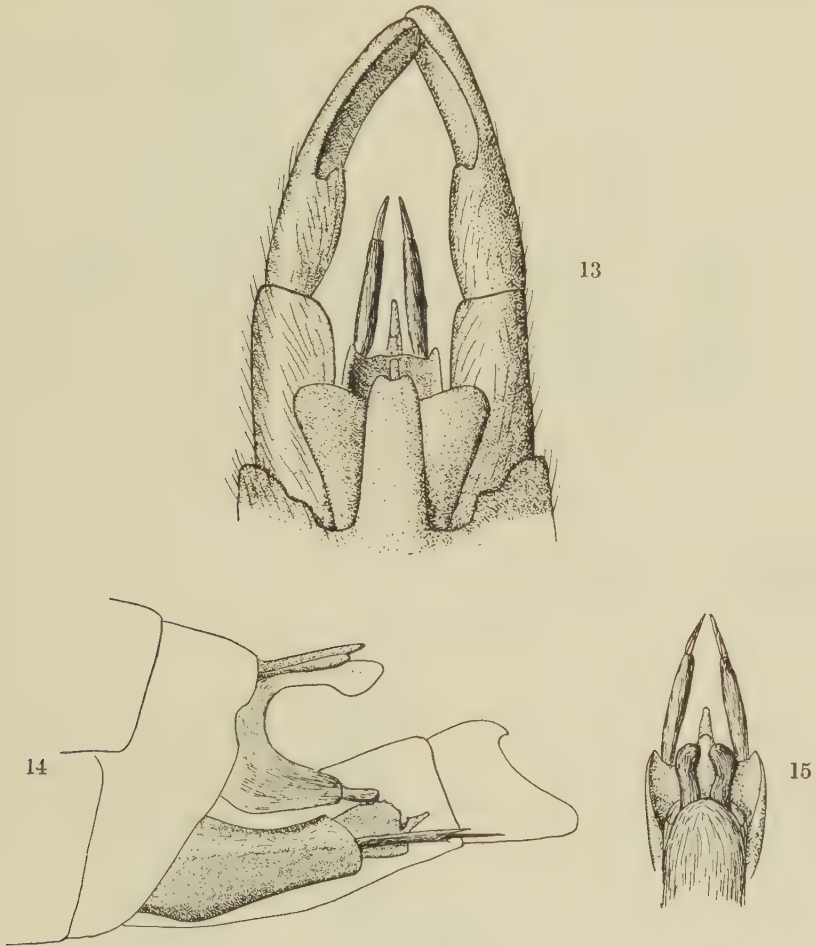
Type ♂ in the author's collection; paratypes ♂ and ♀ in the author's and British Museum collections.

France, Basses-Pyrénées, Eaux Bonnes, 4-21.vii.1929.

This is a fine and conspicuously marked *Rhyacophila*, and when newly emerged, is of a much brighter yellow colour than is described above. It will

find a place in a group of its own between group *hageni* and the *intermedia* group, having characters pertaining to each.

I dedicate this species with pleasure to Mr. A. B. Martynov in recognition of the great advance he has made to the knowledge of Asiatic Trichoptera.



FIGS. 13-15.—*Rhyacophila martynovi*, sp. n. ♂. 13 genitalia dorsal, 14 lateral, 15 penis and upper penis-cover dorsal.

Family HYDROPTILIDAE.

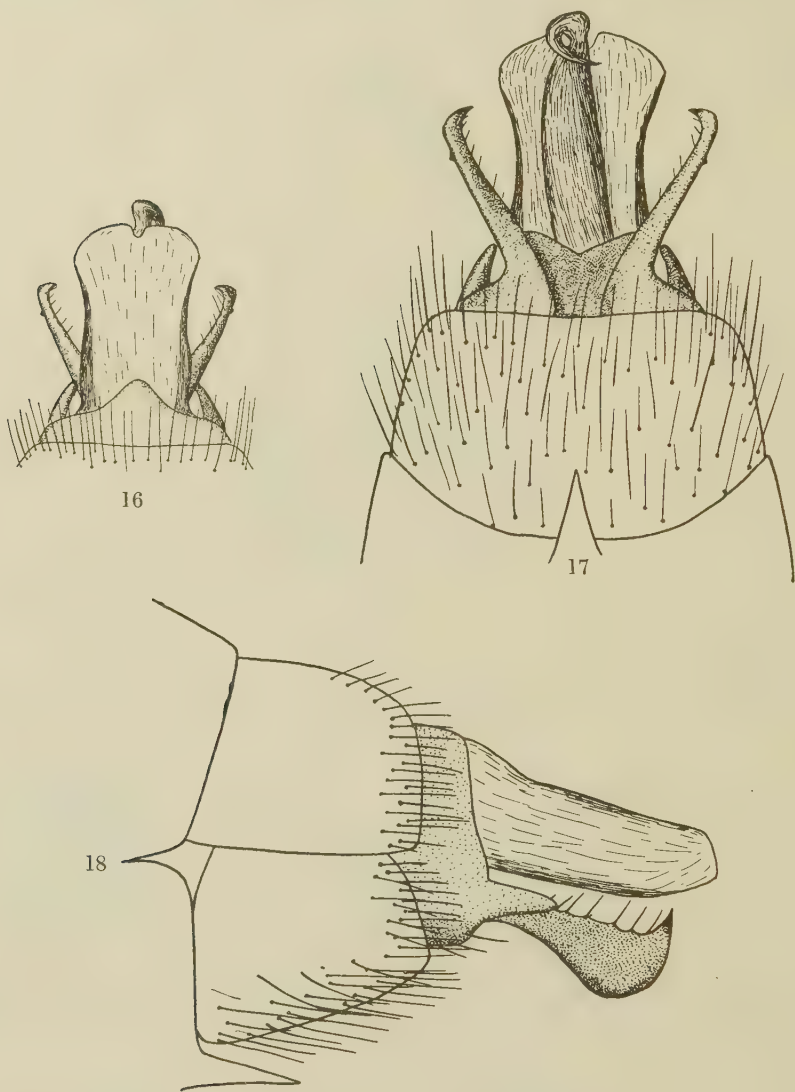
Hydroptila lotensis, sp. n. Figs. 16-18.

I am unable to give a description of the general appearance of this species, as examples were collected in fluid. *Lotensis* will fall within the *sparsa* group.

Antennae, about 33-jointed in the ♂.

Genitalia, ♂. Last dorsal segment produced in centre in triangular process; dorsal plate long, with parallel sides, apex rounded with a very small excision in centre and rounded apical corners; side processes long and narrow; inferior appendages from the

side, with apex widely dilated, rounded and terminating in an upturned beak-like process; upper margin carrying a series of strong spines; ventral plate widely excised; ventral tooth on anti-penultimate segment.



FIGS. 16-18.—*Hydroptila lotensis*, sp. n. ♂. 16 genitalia dorsal, 17 ventral, 18 lateral.

Scent-organ, consists of two eversible filaments clothed with whitish hairs arising from beneath acorn-shaped caps as in *simulans*.

Genitalia, ♀. As is usual in the *sparsa* group.

Expanse, ♂, 6-7 mm.

Type ♂ is a balsam preparation in the author's collection; paratypes ♂ and ♀ in author's and British Museum collections.

France, Lot, Cahors, 30.vi.1924.

This insect bears a strong resemblance to both *simulans* and *cornuta*, as may be seen in the shape of the inferior appendages and the nature of the scent-organ.

***Hydroptila kimminsi*, sp. n.** Figs. 19–21.

Pl. XIV; fig. 1.

The specimens were collected in fluid, consequently I am unable to give a description of their general appearance.

The species forms one of a group closely allied to *H. occulta*, Eaton.

Antennae about 31-jointed in the ♂.

Genitalia, ♂. Dorsal plate long, apex widely excised on each side of centre, which is produced to an obtuse angle; side-pieces from above, short; from the side, broad at the base; penis long and straight, with no dilatation; penis-sheaths * projecting beyond the penis, sinuate and only slightly dilated before apex; seen from the side, curving upwards beyond margin of dorsal plate; inferior appendages from the side, nearly as long as dorsal plate, broad at the base with a distinct tubercle on lower margin, then slightly narrowing, then dilating in a downward sweeping curve to an obliquely truncated apex; seen from beneath, they are parallel-sided, with rounded apices, tubercles at bases appearing as ovoid lobes.

Scent-organ, fashioned according to the *occulta* type, but differs in detail. Lining the scent-organ caps are three groups of long specialised scent-hairs, one group arising towards the base with very long hairs, the second along a central line also with long hairs and the third with rather shorter hairs situated towards the apex. On the membrane at the base of the caps is a small group of scent-hairs and there is a portion of the membrane, possibly capable of slight dilatation, thickly covered with elongate, striate scent-scales. Owing to lack of material, it has been difficult to show the exact relative positions of the scale-clad membrane and the scent-organ caps.

Expanse, ♂, 5–6 mm.

Type ♂ is a balsam preparation in the author's collection; paratypes ♂ in author's collection.

France, Lozère, Mende, 3–8.vii.1924.

I dedicate this species to Mr. D. E. Kimmins, who, in making the drawings for this paper, noticed that *kimminsi* and *cognata* were specifically distinct.

***Hydroptila cognata*, sp. n.** Figs. 22–24.

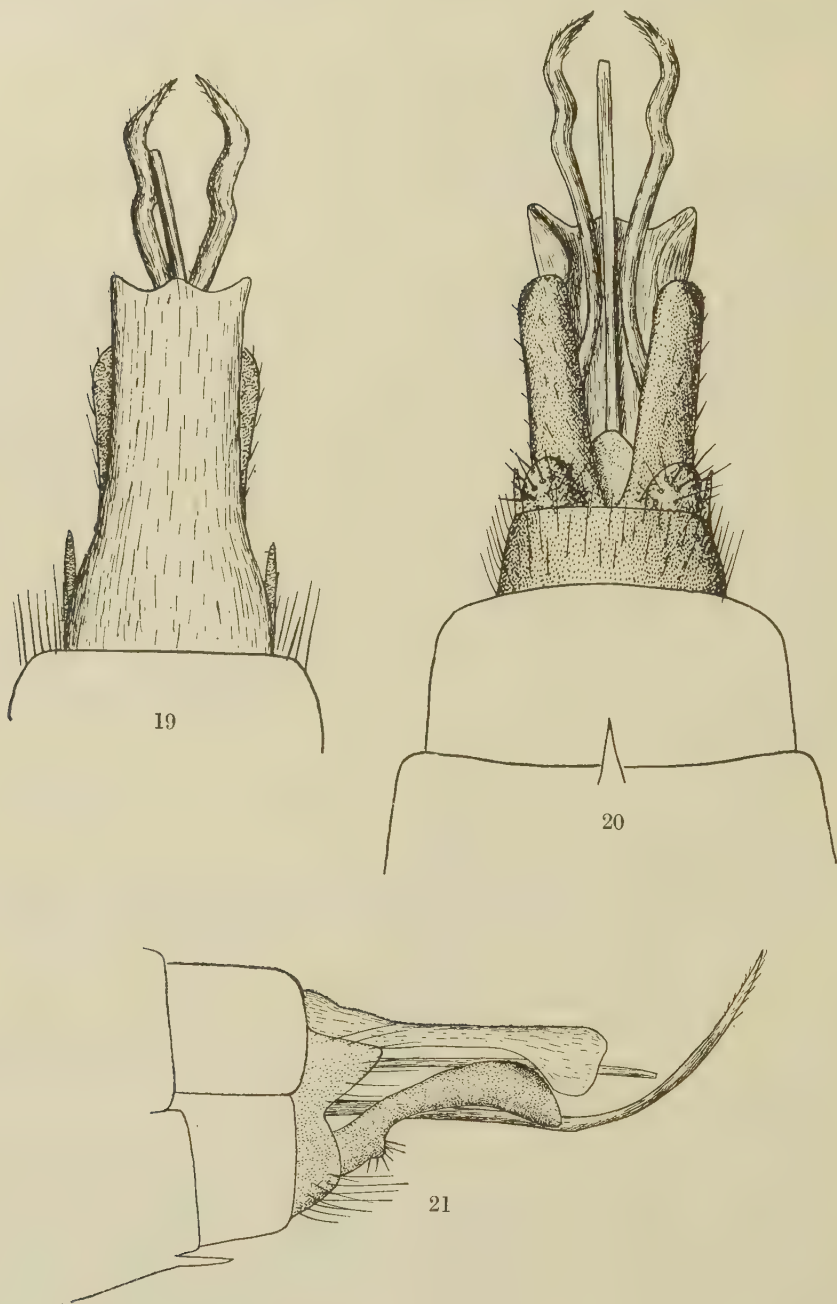
Pl. XIV; fig. 2.

Specimens were collected in fluid, so that a general description is not possible. The species is closely allied to *H. occulta*, Eaton.

Antennae, about 27-jointed in the ♂.

Genitalia ♂. Dorsal plate long, from above, apex truncate, with the angles produced

* Martynov in Contributions to Aquatic Entomofauna of Turkestan, *Annu. Mus. Zool. Acad. Sci. U.R.S.S.*, 28: 176, 1927, in his description of *Hydroptila insignis*, states that the upcurved appendages, described by McLachlan and above as penis-sheaths, do not belong to the penis but represent upper branches of the inferior appendages (pedes genitales). Whilst I am inclined to agree with him that they are not true penis-sheaths, I consider them a modification of the lower penis-cover rather than branches of the inferior appendages to which I can find no attachment. It is perhaps desirable to continue to refer to them as penis-sheaths as there is evidently a considerable group of species of the *occulta* type, and it will be more convenient, for purposes of comparison, to maintain McLachlan's descriptive terms even though they may not be strictly accurate in anatomical detail.



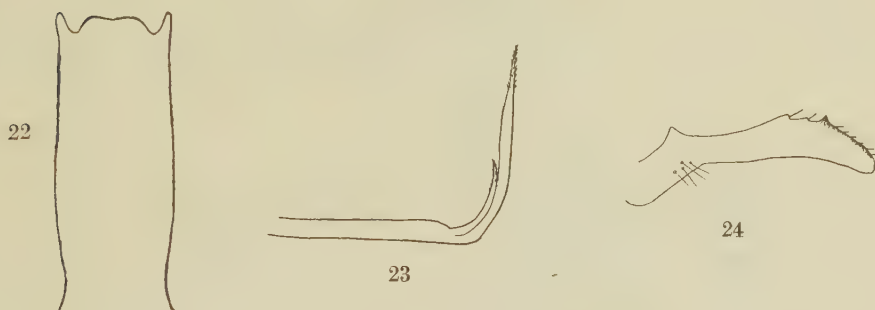
FIGS. 19-21.—*Hydroptila kimminsi*, sp. n. ♂. 19 genitalia dorsal, 20 ventral, 21 lateral.

to form acute processes inside which are deep excisions; side-pieces rather short, from the side, very broad at base; penis-sheaths long, slender, scarcely dilated, asymmetric, the right sheath carrying a small branch, arising on its inner side towards the apex, at a point where the sheath is abruptly bent upward; inferior appendage shorter than dorsal plate; from the side, towards base, there is a small triangular projection along upper margin, the latter being strongly serrate and blackened towards apex; no tubercle on lower margin as in *kimminsi*, but the tubercle is replaced by a small tuft of long hairs.

Scent-organ on the plan of *occulta* but differing in detail. Scent-organ cap densely lined with long striate scent-scales, arranged along a sinuous line; towards apex, on inner side, is a membranous process, probably capable of dilatation, carrying striate scales; towards the base of each cap is a tuft of scent-hairs, and a membrane, perhaps capable of dilatation, densely clothed with somewhat sinuous striate scent-scales.

♀ conforming to the *occulta* type.

Expanse, ♂, 5 mm.



FIGS. 22-24.—*Hydropstila cognata*, sp. n. ♂. 22 dorsal plate, 23 right penis-sheath, internally, 24 inferior appendage.

Type ♂ is a balsam preparation in the author's collection; paratypes ♂ in the author's and British Museum collections.

France, Pyrénées-Orientales, Quillan, 18-22.vi.1923.

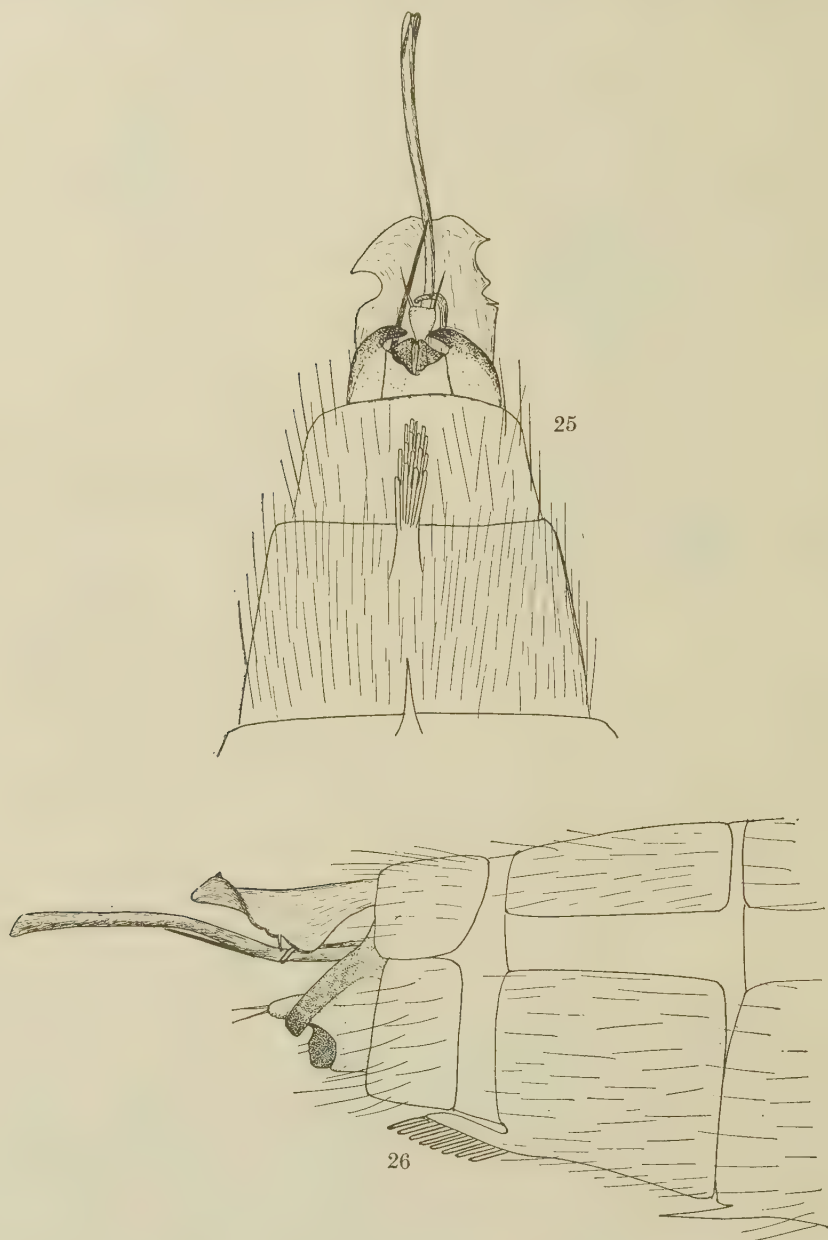
***Orthotrichia tragetti*, sp. n. Fig. 25-26.**

Pl. XIV; fig. 3. *O. angustella*, McL.

The examples were collected in fluid and it is not therefore possible to give a description of their general appearance.

Genitalia, ♂. Dorsal plate asymmetrical; seen from beneath, long and broad; from centre of apical margin, obliquely truncate towards the left, then a deep rather more than semi-circular excision, then proceeding vertically to the last segment; from the centre of apex towards the right, curving slightly downward, then an acute angle followed by a shallow excision, then an obtuse angle followed by a rather deeper excision, then a narrow-pointed process followed by a very narrow excision, margin then proceeding in straight line to segment; towards their bases, lower portion of side-pieces strongly chitinised, curving round ventrally to form finger-like processes, apices blackened; beneath are two triangular plates, apices approaching each other with a narrow vertical cleft separating their inner sides; these plates are partly covered by a further plate with margin strongly chitinised and its apex showing a broad and sinuous excision; above the plates is a semi-transparent plate, narrow at the base with broad apex, the upper angles carrying strong hairs or spines;

penis very long, narrow towards apex, very broad towards base; a single sheath (?) is seen from beneath, strongly elbowed at base, sloping towards the penis with apex touching



FIGS. 25-26.—*Orthotrichia tragetti*, sp. n. ♂. 25 genitalia ventral, 26 lateral.

it; ventral process of 7th segment very large and clothed with very stout blunt hairs; small process to 6th segment.

♀ unknown.

Expanse, ♂, 6 mm.

Type and paratypes ♂ in the author's collection.

England, Hampshire, lake at Aubridge Danes, Romsey, 31.vii.1915.

France, Ain, La Dombes, St. Paul-de-Yarax, 6.vii.1925.

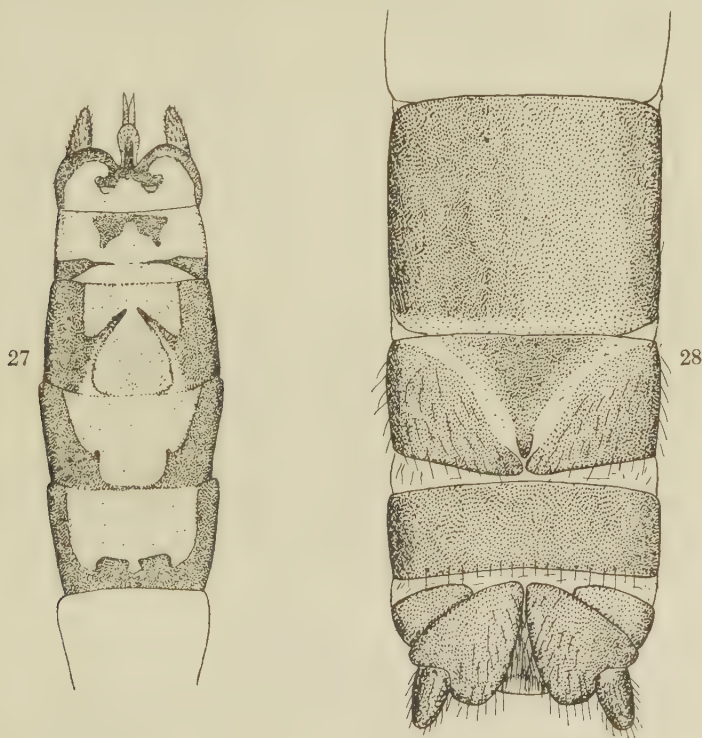
This species may be distinguished from *O. angustella* by the shape of the dorsal plate, other parts of the genitalia, and the absence of black scales along the costal margin of the anterior wings towards the base. These scales in *angustella* have not hitherto been noticed in accounts of the species, so I give a figure to show their position on the wing.

O. tragetti is evidently closely allied to *O. cristata*, Morton, and I dedicate the species to the Tragett family, through whose courtesy I had frequent access to the lake on their estate.

PLECOPTERA.

Leuctra despaxi, sp. n. Figs. 27-28.

This insect resembles *Leuctra cylindrica*, De Geer, and is no doubt the species doubtfully recorded by Despax under that name.



FIGS. 27-28.—*Leuctra despaxi*, sp. n. 27 genitalia ♂, dorsal, 28 genitalia ♀, ventral.

Genitalia, ♂. Processes of 6th dorsal segment broad, centrally situate, and inclining slightly towards each other; 7th dorsal segment with strongly chitinated side-plates extending inwards and forming an arch, with broad base; towards the apex of the arch are two small down-turned, blackened processes; processes of 8th segment directed downward, long, acute sloping towards each other with blackened apices; on 9th dorsal segment

there are narrow chitinous plates, broad at sides, extending towards each other across the segment and narrowing to fine points; below them is a shading of the integument shaped as a double triangle with margin and inner sides sinuate; "rose-shaped" process of the genitalia, rather long and narrow.

Genitalia, ♀. Sub-genital plates inclining towards each other, lower margins straight and nearly horizontal, inner margins cut away to form an excision, very wide at base; in centre of excision is a small lobe with blackened apex.

Length of body, ♂, 10 mm.; expanse, 17 mm.

" " " ♀, 12 mm.; " 21 mm.

Type ♂ is a balsam preparation in the author's collection; paratypes ♀♀ in the author's and British Museum collections.

France, Pyrénées-Orientales, Mont Louis, 22.vi.-2.vii.1923; Cantal, Le Lioran, 9-19.vii.1924; Basses-Pyrénées, Eaux Bonnes, 4-21.vii.1929.

I have great pleasure in dedicating this species to Monsieur R. Despax, whose careful work on the Pyrenean Plecoptera merits full recognition.

***Protonemoura pyrenaica*, sp. n. Figs. 29-31.**

Wings, brown, shaded along nervures.

Genitalia, ♂. From the side, supra-anal lobe (*l*) with a deep excision on the upper surface at the apex, the lower surface carrying a tuft of strong black spines; intermediate appendages (*m*, *appendices moyen* of Despax) membranous, forked, the upper branch long and narrow; support of the intermediate appendage (*s*, *tigelle de soutien*), with a slight angular projection on centre of upper surface; sub-anal plate (*p*, *plaque sous-anales*), small, triangular, inclining downward; process of sub-anal plate (*p'*), black, carrying several strong black spines or teeth on its lower surface and directed upward along upper fork of *m*; ventral process (*v*, *vésicule ventrale de la plaque sous-génitale*), nearly as long as sub-genital plate (*g*).

From above, supra-anal lobe, long, terminating in a blackened triangular apex with concave sides; intermediate appendages (*m*), long narrow and membranous; support of intermediate appendages (*s*) visible at its apex which is obliquely T-shaped, its outer margin bordered with a lunate-shaped membrane which is the apex of the upper fork of *m*; process of sub-anal plate (*p'*) just visible at its apex, showing a small cluster of spines.

From beneath, intermediate appendage (*m*) long and narrow, its support (*s*) sinuate with broad, obliquely truncate apex; sub-anal plate (*p*) rounded, its process (*p'*) angulated outward and extending nearly as far as apex of *s*, its outer side armed with strong black spines; ventral process (*v*) long, narrowish with a lightly-coloured oval patch at its base.

Length of anterior wing, 7 mm.

♀ unknown.

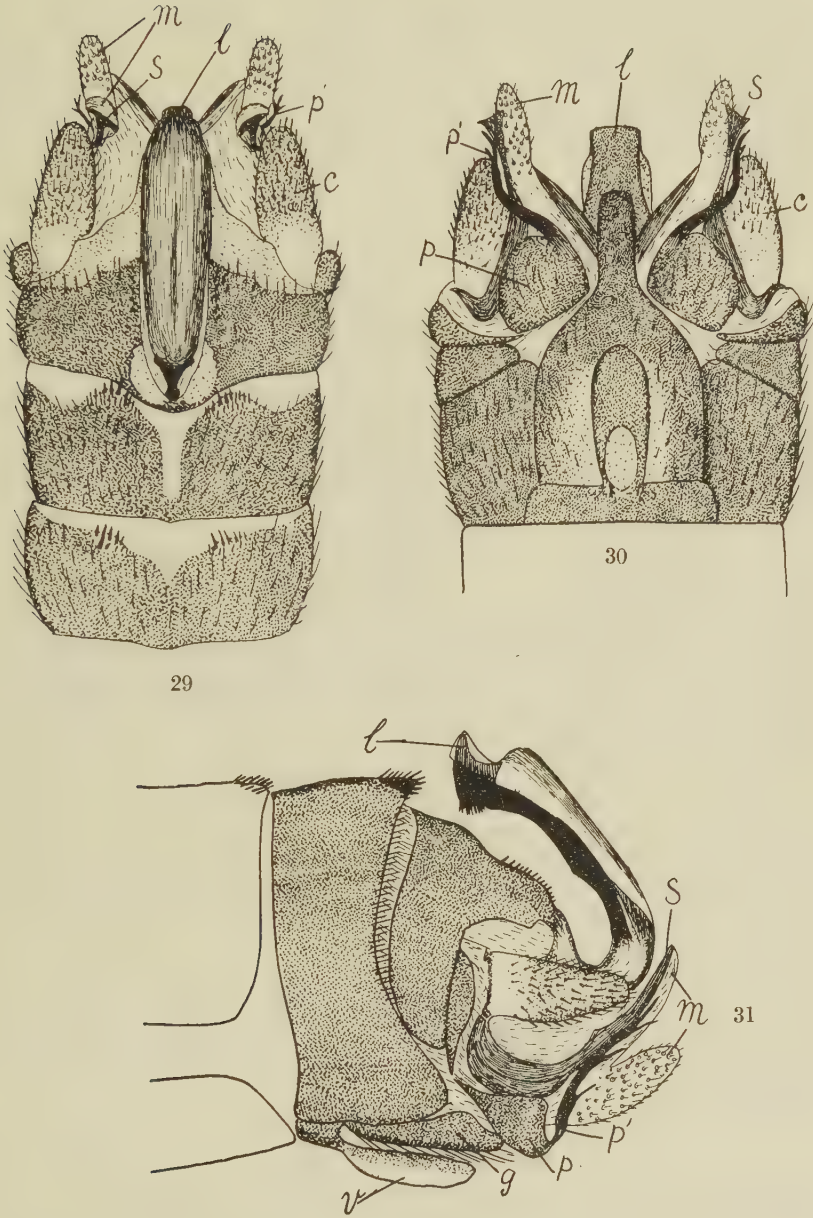
Type ♂ is a balsam preparation in author's collection.

France, Basses-Pyrénées, Eaux Chaudes, 10.vii.1929.

This species is very closely allied to *P. meyeri*, Pict. It differs chiefly in the form of *p'* and *s*. The neuration is not so strongly shaded as in *meyeri*. It is also related to *P. beatensis*, Despax. I have adopted the terminology and lettering used by Despax, in his very lucid description of Pyrenean Plecoptera.

***Protonemoura nimborella*, sp. n. Figs. 32-33.**

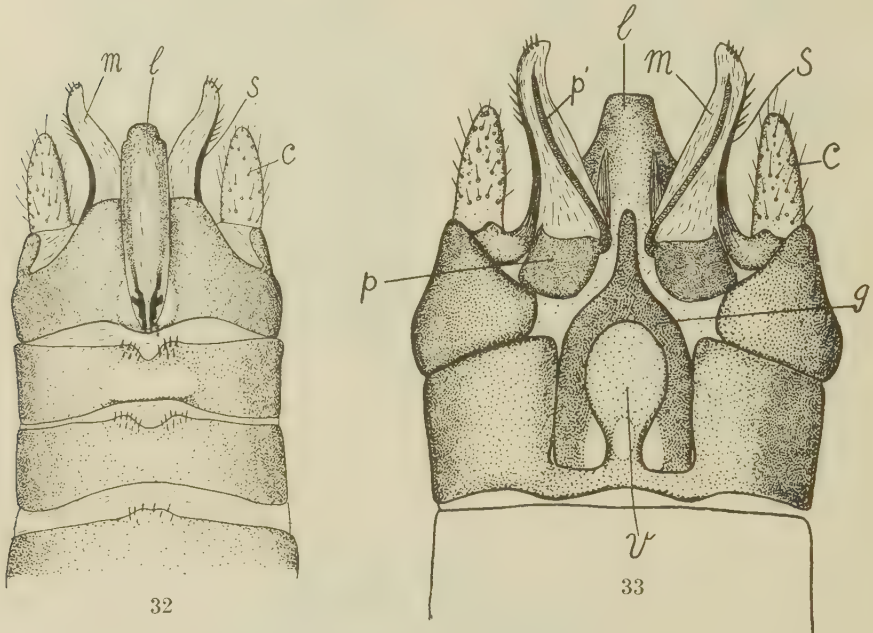
Two examples of this species were taken at Klosters in Switzerland and were mounted in Canada balsam.



FIGS. 29-31.—*Protonemoura pyrenaica*, sp. n. ♂. 29 genitalia dorsal, 30 ventral, 31 lateral. *c*, cerci; *g*, subgenital plate; *l*, supra-anal lobe; *m*, intermediate appendages; *p*, sub-anal plate; *p'*, process of sub-anal plate; *s*, support of intermediate appendages; *v*, ventral process.

Wings, brownish, neuration strong, membrane bordering nervures slightly tinged with brown as in *P. meyeri*.

Genitalia, ♂. From above, supra-anal lobe (*l*) long, apex somewhat sagittate; intermediate appendages (*m*) very long, projecting considerably beyond the cerci; support of the intermediate appendage (*s*) bearing groups of five or six strong spines midway, and three or four towards the apex; from beneath, ventral process (*v*) narrow at base, considerably dilated towards apex, with a lightly coloured rounded patch towards the base;



FIGS. 32-33.—*Protonemoura nimborella*, sp. n. ♂. 32 genitalia dorsal, 33 ventral. *c*, cerci; *g*, sub-genital plate; *l*, supra-anal lobe; *m*, intermediate appendages; *p*, sub-anal plate; *p'*, process of sub-anal plate; *s*, support of intermediate appendage; *v*, ventral process.

intermediate appendage (*m*) wide at the base, directed slightly outward, then narrowing to a sub-acute, incurved apex; sub-anal plate (*p*) broad, upper margin sinuate; process of sub-anal plate (*p'*) arises from a nodule at the upper inner angle, very long and slender, terminating in a single strong spine.

Length of anterior wing, 8 mm.

♀ unknown.

2 ♂ cotypes in a balsam preparation in the author's collection.
Switzerland, Klosters, 12-30.viii.1928.

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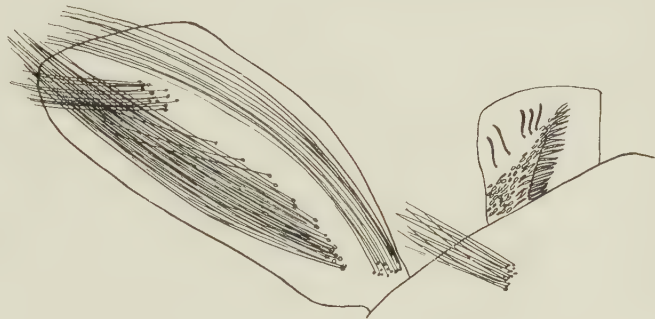
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PLECOPTERA.

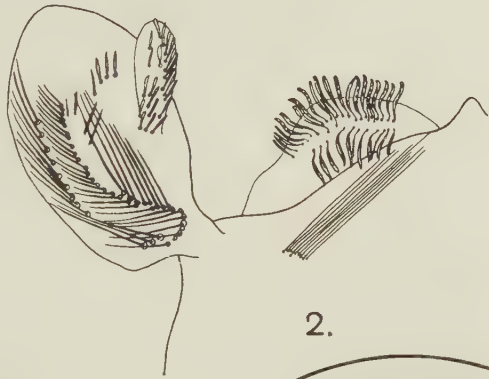
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EXPLANATION OF PLATE XIV.

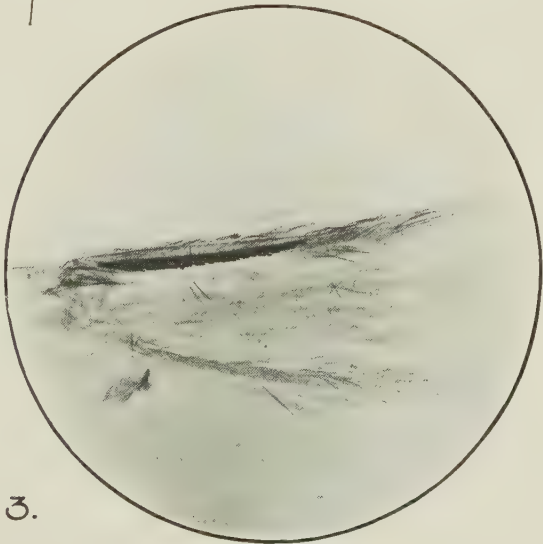
- FIG. 1. *Hydroptila kimminsi*, sp. n. Scent-organ.
2. *Hydroptila cognata*, sp. n. Scent-organ.
3. Anterior wing of *Orthotrichia angustella*, McL.



1.



2.



3.

DETAILS OF NEW EUROPEAN TRICHOPTERA.

A REVISION OF THE GREENLAND SPECIES OF THE ANTHOMYID
GENUS *LIMNOPHORA* SENS. LAT. (DIPTERA), WITH FIGURES
OF THE MALE GENITALIA OF THESE AND MANY OTHER
PALAEARCTIC SPECIES.

By J. E. COLLIN.

[Read 4th June, 1930.]

PLATES XV TO XXVII.

THIS group, and especially the genus *Spilogona*, is very numerous in species in Northern regions, but though a large number have been described by Zetterstedt, Holmgren, Boheman, Stein, Schnabl, and, in more recent years by my friend Mr. O. Ringdahl of Halsingborg, the specific distinctions in many cases are neither obvious nor constant, making the group particularly difficult, and the identification of the species inhabiting a particular region often a matter of conjecture. To overcome this difficulty I was led to investigate the structure of the male genitalia when working out the species brought from Greenland by the Oxford University Expedition in 1928, to find, as so often is the case, abundant characters for the differentiation of the species. Through the kindness of Inspector Lundbeck of the Copenhagen Museum I have been able to study the rich collection of specimens from Greenland in that institution; the Director of the Philadelphia Academy of Science has allowed me to examine the paratypes of the Greenland species described by Malloch; Professor Sjöstedt of the Stockholm Museum has very kindly sent me the specimens in the Holmgren and Boheman collections and allowed me where necessary to dissect the types; while Mr. O. Ringdahl of Halsingborg and Mr. H. C. Hockett of New York have been most generous in sending me specimens and giving information. Thanks to this assistance, the acknowledgement of which gives me much pleasure, I have been able nearly to double the number of species known to occur in Greenland, bringing the total up to 22, and to figure the male genitalia of all species where the male is known (except *extensa*, Mall.), besides clearing up many points in synonymy. In addition I have given figures of the male genitalia of many allied Palaearctic species including all the British species of *Pseudolimnophora* and *Spilogona*. The last abdominal sternite is figured because both in shape and chaetotaxy it affords valuable specific characters and has the advantage of always being to some extent visible. The genitalia are of the usual Muscid type, and consist (Pl. xxiii, fig. 6*b* + *c*) of the fused anal or upper lamellae sometimes called the superior forceps ("Obere Zangen" of Schnabl) "al" of figure; the side lamellae "sl" ("Untere Zangen" or lower forceps); and a complicated structure with two paired appendages which carries the penis. The foundation of this structure is the "fulcrum penis" of Schnabl, which is connected to the shell of the hypopygium as shown in figure 6*b* + *c*, and this "fulcrum" may be of very different shape in different species; the anterior appendages "aa" are connected to the fulcrum, the posterior appendages "pa" (which are often membranous or at least hyaline towards the tip) being connected to the penis. In the figure the projecting part between "pa" and "aa" is the penis.

The penis bears a "stylus" ("s"), which may be more or less developed, while the chitinous part of the end of the penis appears to be very constant in

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shape within the limits of a species; at the base of the penis is the "apodeme" ("ap") for attachment of muscles.

Owing to lack of material it has been impossible in many cases to dissect more than one specimen. It must be left to future workers to discover the variation, if any; but a warning is perhaps necessary in regard to apparent differences in shape due to the point of view, particularly in the case of the side lamellae.

The figures have all been drawn immediately after dissection, and before mounting.

1. *Pseudolimmophora rotundata*, sp. n. ♂. Plates XV and XIX.

This is the male of the species recorded by Lundbeck as *L. triangula*, Fall.; it cannot be that species because it has four postsutural dorso-central bristles, a rather wider frons with more concave sides to frontalia, and four distinct long bristles on the very short 1st abdominal sternite, this sternite being apparently always bare in *triangula*.

The single specimen has lost its four anterior legs, but it differs from my Scottish *nigripes* in having the frons viewed from in front more greyish-brown instead of silvery, no front sternopleural bristle, narrower if not longer wings, two pairs of longer bristles on first abdominal sternite instead of the single pair of *nigripes*, and 3-4 small bristles both above and below the extreme base of radial vein instead of the usual 1-2 of *nigripes*.

Ample specific differences occur in the genitalia of the two species as may be seen in the figures, especially in the shape of the side lamellae ("Untere Zangen" of Schnabl).

Length 3.5 mm.

WEST GREENLAND: Tassiusak (Lundbeck), 1 ♂.

The female of the pair recorded by Lundbeck as *L. triangula* is a *Spilogona* and not a *Pseudolimmophora*, having the prosternum bare and no bristles on radio-cubital node of wing-venation. I believe it to be the female of *deflorata*.

2. *Limnophora sinuata*, sp. n. ♂. Plates XV and XIX.

A species of the subgenus *Limnophora* resembling a very small *uniseta*, but third antennal joint shorter and abdominal dark markings more triangular.

♂. Eyes separated on frons by narrow silvery orbits and wider black frontalia, so that at narrowest part it is wider than third antennal joint. Epistoma distinctly projecting. Antennae short, arista microscopically pubescent. Proboscis long, slender, polished black. Palpi very long, slender, dilated at tip.

Disc of thorax bluish-grey in front, the rest more brownish with the brown colour projecting into the grey anteriorly in three indistinct stripes; seen from behind the grey colour in front is less evident except on humeri and notopleural depression, where contrast in colour is very marked; seen immediately from behind there is a greyish patch in front of scutellum. Scutellum same colour as disc and not grey from any point of view. Four postsutural dorso-centrals. Acrostichals irregularly biserial in front.

Abdomen rather narrow, slightly wider at base than at tip; grey when seen from behind with first segment largely black, 2nd and 3rd segments with large triangular, narrowly separated, patches spreading out along hind margin almost to sides, and occupying (at least on 2nd segment) the whole length. First sternite apparently quite bare. Hypopygium greyish.

Middle femora with 3-4 long bristles on basal third beneath, a row of depressed bristles on basal half in front and a pair of postero-dorsal preapical bristles; hind femora with the usual antero-dorsal row of bristles, 2-3 towards tip antero-ventrally, but quite short-haired postero-ventrally. Front tibiae without bristle behind; middle tibiae with two small

bristles behind; hind tibiae one antero-ventral and one antero-dorsal bristle. Wings with very short and fine costal ciliation and only 1-2 small fine bristles on radio-cubital node. Squamae white. Halteres yellow.

Length 3.5-4 mm.

WEST GREENLAND: Orpiksuit, 19.7.90 (*Lundbeck*), 1 ♂.

EAST GREENLAND: Hekla Havn, 8.91 (*Deichmann*), 1 ♂.

Malloch described in 1920 (*Trans. Amer. Ent. Soc.*, 46: 147) a *L. groenlandica* from the female only, which according to a MS. note by the author in a copy of this paper received by me is a "*Limnophora vera*," that is to say it belongs either to the subgenus *Limnophora* or to *Pseudolimnophora*. His species appears to differ from either of my new species in having an antero-dorsal bristle to middle tibiae and hind tibiae with "a weak antero-dorsal bristle apicad of the strong one."

TABLE OF GREENLAND SPECIES OF *SPILOGONA*.

- 1 (30). *Epistoma* not, or very slightly produced beyond level of profrons.
The theca of proboscis is dusted greyish except in *malaisei*, *monacantha*, *semiglobosa*, and female of *arctica* (probably also *trigonifera* ♀); in males of *trigonifera* and *arctica* it is shining with a dusted patch about middle beneath.
- 2 (3). Eyes widely separated in male by a distance equal to length of 3rd antennal joint. Small bluish-grey species with (normally) only 3 postsutural dorso-centrals and no long postero-ventral bristly hairs to hind femora *alpica*, Zett.
- 3 (2). Eyes not so widely separated in male, or if widely separated, not bluish-grey species.
- 4 (7). Normally only three pairs of postsutural dorso-central bristles on thorax.
- 5 (6). Darker species. Abdomen of male more tubular. Bristles on costa up to end of mediastinal vein shorter than costa is stout. Proboscis stout, theca shining or at least with only a dusted patch about middle beneath *arctica*, Zett.
- 6 (5). Greyer species. Abdomen of male more dorso-ventrally compressed. Proboscis more slender, theca dull dusted greyish . . . *tornensis*, Ringd.
- 7 (4). Normally four pairs of postsutural dorso-centrals.
- 8 (19). No distinct postero-ventral bristles to hind femora.
- 9 (12). Middle femora with only one strong postero-ventral bristles or without any bristle.
- 10 (11). Thorax grey, abdominal dark patches larger. Female with middle femora quite bare beneath *monacantha*, sp. n.
- 11 (10). Thorax darker, abdominal dark patches smaller. Female with a single spine beneath near base as in male *semiglobosa*, Ringd.
- 12 (9). Middle femora with the usual row of bristly hairs postero-ventrally.
- 13 (14). Thorax extensively greyish. Halteres yellow. If female then spines to ovipositor *denudata*, Holmgr.
Cf. also *obsoleta*, Mall., of Section 19 (8).
- 14 (13). Thorax black or at least not extensively grey. If female and thorax grey then no spines to ovipositor.
- 15 (18). Middle tibiae without bristle beneath. Scutellum with apical setulae. Smaller species.
- 16 (17). Theca of proboscis dull. Abdomen of male viewed from behind grey with strongly contrasted dark patches, of female not unicolorous shining blackish *deflorata*, Holmgr.

- 17 (16). Theca of proboscis shining. Small blackish species. Abdomen of male having less strongly contrasted patches, and of female unicolorous shining black *malaisei*, Ringd.
- 18 (15). Middle tibiae with bristle beneath. Scutellum without apical setulae. Larger darker species with abdominal markings large and ill-defined. *latilamina*, sp. n.
- 19 (8). At least a few longer postero-ventral bristly hairs to hind femora.
- 20 (21). Middle tibiae with 2-3 small bristles beneath. Face dusky and "lunula" between and above base of antennae blackish. Proboscis stout in male, very stout and only slightly dusted in female. *obsoleta*, Mall.
- 21 (20). Middle tibiae without bristles beneath. Face and "lunula" greyish or silvery.
- 22 (27). Proboscis entirely dusted greyish.
- 23 (26). All thorax or at least presutural area distinctly greyish. Smaller species. Female ovipositor spinose.
- 24 (25). Postero-ventral bristles on basal half of hind femora short and inconspicuous *denudata*, Holmgr.
- 25 (24). Postero-ventral bristles to hind femora long and distinct. Male thorax distinctly grey on presutural area . . . *micans*, Ringd.
- 26 (23). Thorax black. Large species *opaca*, Schnbl.
- 27 (22). Proboscis with theca shining except for (at least in male) a dusted patch beneath.
- 28 (29). Larger species with more dorso-ventrally flattened abdomen in male. *trigonifera*, Zett.
- 29 (28). Smaller species with male abdomen more tubular . . . *arctica*, Zett.
- 30 (1). Epistoma more or less distinctly produced beyond level of profrons. Theca of proboscis shining, not dusted greyish. In *megastoma* the theca is slightly dusted about base beneath, and in the Scandinavian *L. triangulifera*, Zett. (of which I have not seen a Greenland specimen), it is entirely dusted.
- 31 (36). Long distinct postero-ventral bristly hairs to hind femora.
- 32 (35). A distinct protuberant "keel" between bases of antennae.
- 33 (34). Larger, darker species with narrow dark stripes on thorax down lines of bristles. Female with broad, densely haired frontal orbits. *almquisti*, Holmgr.
- 34 (33). Smaller greyer species. Dark thoracic stripes if present between rows of bristles *extensa*, Mall.
- 35 (32). No distinct protuberant keel between antennae. *megastoma*, Bohem. Cf. *sanctipauli* in which hind femora usually have short postero-ventral bristly hairs.
- 36 (31). No long distinct postero-ventral bristly hairs to hind femora.
- 37 (40). No bristles beneath middle tibiae.
- 38 (39). Thorax grey with three narrow brownish stripes down lines of bristles. Hind femora usually with short postero-ventral hairs not longer than femur is thick *sanctipauli*, Mall.
- 39 (38). Thorax blackish without stripes. Small dark species with no distinct postero-ventral hairs to hind femora *malaisei*, Ringd.
- 40 (37). Small bristles beneath middle tibiae.
- 41 (42). Postsutural dorso-centrals strong, other pubescence short and more scanty; presutural acrostichals almost biserial with a few others close to dorso-centrals. Cross-veins somewhat infuscated *hyperborea*, Bohem.
- 42 (41). Postsutural dorso-centrals weak, other pubescence long. Acrostichals multiserial. Abdomen entirely dark *macropyga*, Frey.

In the following descriptions species, except No. 8, are arranged in alphabetical order.

3. L. (*Spilogona*) *almquisti*, Holmgr. Plates XV and XX.

1881. *Aricia almquistii*, Holmgren, Nov. Spec. Ins. Nordenskiöld. Nova. Sem. desc., p. 17, and 1883, Ent. Tidskr., 4: 167.
 1920. *Limnophora rostrata*, Ringdahl, Ent. Tidskr., 41: 26.
 1920. *Limnophora angulata*, Malloch, Trans. Amer. Ent. Soc., 46: 151.

♂. Eyes separated on narrowest part of frons by only width of very narrow frontal orbits so that here it is but little wider than width of front ocellus. Frontal bristles very fine. Facial orbits almost as wide as third antennal joint. Jowls deep, quite $\frac{1}{3}$ vertical diameter of eye. Antennae separated by a protuberant rounded, facial keel, third joint short, no longer than first two together; arista microscopically pubescent. Epistoma projecting. Proboscis rather slender with theca polished, only slightly dusted at extreme base.

Thorax dull dark greyish-black with five more or less distinct black stripes; humeral area rather lighter. Four rather fine postsutural dorso-central bristles; general pubescence conspicuous. Scutellum black with hairs extending downwards on to sides, at least towards tip.

Abdomen with very extensive dark markings, usually leaving only the base of tergites (even also on fourth) towards sides narrowly greyish, but there may sometimes be an indication of median greyish stripe. In profile truncate at tip; basal part of hypopygium deeply cleft right up to the prehypopygial tergite. First sternite often with 1-2 tiny bristles.

Legs with conspicuous bristly hairs on all femora; numerous long postero-ventral bristly hairs on middle femora and some shorter finer antero-ventral ones; a complete antero-ventral row of long bristles on hind femora becoming stronger towards tip and a postero-ventral row on basal half; front tibiae with 1-2 fine bristles behind; middle tibiae occasionally with small bristle in front and 2-3 long ones behind, close together; hind tibiae with 3-4 antero-ventral, 3 antero-dorsal and 2-3 postero-dorsal bristles. Ungues and pulvilli rather long. Wings slightly brownish at base only. Squamae whitish with pale yellow margins. Halteres darkened.

♀. Frontal orbits wide, brownish, somewhat elevated and bearing numerous bristles but little shorter than frontal bristles, outcurved on upper part, incurved below, interfrontalia reaching to front of frons and faintly shining in some lights on upper part. Facial orbits and jowls wider than in male. Eyes distinctly small.

Thorax similar to male but rather lighter in colour. Abdomen extensively darkened as in male but dark part faintly shining in some lights and fourth tergite grey. Ovipositor with ovate yellowish terminal lamellae without spines.

Legs with chaetotaxy much as in male but more usually 1-2 bristles in front of, and stronger bristles behind, middle tibiae.

Length 6-7 mm.

EAST GREENLAND: Hekla Havn, 8, 91 (*Deichmann*), 1 ♀; Cape Dalton, 7, 1900, 2 ♀.

WEST GREENLAND: Har-ön, Nordskj. Exp. '83, 1 ♀, included under *trigoni-fera* in Danish collection. West Coast, Peary Exped. '91 (male and female paratype, and female allotype of *angulata*, Mall.).

Ringdahl's *rostrata* (from which species the figures have been made) is not quite so dark coloured as the Greenland specimens, and the dark patches on abdomen are not so extensive, and more distinctly separated. The male cotype given to me by the describer has also the bristly hairs on femora not quite so long or numerous, but in the female cotype there is very little difference in this respect from Greenland females. I feel very little doubt concerning the correctness of the synonymy, because of the resemblance of my figures with

those of *almquisti* given by Frey in 1915 (*Mem. Acad. Sci. Russ.*, 29 : no. 10, pl. i, figs. 1, 2).

4. *L. (Spilogona) alpica*, Zett., ♂. Plates XVIII and XX.

1845. *Aricia alpica*, Zetterstedt, Dipt. Scand., 4 : 1624.

1915. *Limnophora latifrons*, Stein, Die Anthom. Europas, p. 91.

1918. *Limnophora alpica* (Zett.), Ringdahl, Ent. Tidskr., 39 : 162.

This small dull bluish-grey species is very distinct in the male by reason of its wide frons, which is at narrowest part almost as wide as third antennal joint is long. Proboscis slender, theca dusted except towards tip. Usually only three postsutural dorso-centrals, but occasionally four. Acrostichals rather long and fine, few in number (only about 3 pairs in front of suture). Pleurae darker, brownish-black. Abdomen bluish-grey, practically without markings but varying in colour according to point of view so that when seen from behind it appears broadly brownish down the middle, especially towards base, and this darkening may form indistinct patches. Front tibiae without bristle. Middle femora with 4-5 postero-ventral bristles towards base. Middle tibiae with 1-2 bristles in front and two behind. Hind femora with 4-5 antero-ventral bristles towards tip but short-haired postero-ventrally. Hind tibiae with 2-3 antero-ventral, 2-3 antero-dorsal, and 2 postero-dorsal. Wings distinctly darkened towards base and with dark veins; costal ciliation short. Squamae white. Halteres dark.

WEST GREENLAND : Tasersuak, 14.8.90, at 1200 ft. (*Lundbeck*), 1 ♂. Species No. 139 of "Grönlands Landarthropoder" 1917.

5. *L. (Spilogona) arctica*, Zett. Plates XVI and XXII.

1840. *Anthomyza arctica*, Zetterstedt, Ins. Lapp. Dipt., p. 669.

1845. *Aricia fumipennis*, Zetterstedt (*nec* Stein), Dipt. Scand., 4 : 1465.

This species which has also been recorded from Greenland under the name *contractifrons*, Zett., is so much like that species, that, except for certain characters in the male genitalia, it can only be distinguished with great difficulty. To add to the trouble specimens undoubtedly occur with four postsutural dorso-central bristles, and may vary greatly in size. It is normally darker than *contractifrons*, thorax decidedly less grey, wings more brownish, squamae often rather yellowish, tibiae and tarsi slightly shorter and stouter; the second (antero-dorsal) preapical bristle on the four anterior tibiae appears to be always smaller than in *contractifrons*. The shape of male abdomen (more tubular than usual) is the same in both, and helps to distinguish them from other allied species. Except for the doubtful character of the shorter second preapical bristle to anterior tibiae, I can give no character for separating the females. Numerous dissections of the male genitalia appear to prove the value of the small differences shown in the figures, especially in *arctica* that of the projection on the "fulcrum penis" (of Schnabl) as shown in fig. 5c compared with 31c, and the projection at base of inferior forceps (or side lamellae) when seen from behind.

The use of the name *arctica* appears to be warranted. It is eminently suitable owing to the more northern range of the species, while Zetterstedt recorded specimens from Greenland taken by Westermann, and one of these I have been able to examine and dissect.

Aricia fumipennis of Zetterstedt is a synonym according to Ringdahl, who has examined the original specimens at Lund; apparently therefore Zetterstedt immediately after sinking his species *arctica* as a synonym of *contractifrons* redescribed it as *fumipennis*.

I have seen specimens of *arctica* from Northern Scandinavia as well as from Greenland, but cannot say whether this species and *contractifrons* have a separate and distinct distribution or whether they, somewhere, occur together. It may well prove more correct to consider *arctica* a subspecies, especially as there appear to be other forms of *contractifrons* in Sweden differing only in small details of the genitalia. For instance, of two males of *contractifrons* received from my friend Ringdahl, one from "Storlien" agrees in genitalia with British and Central European specimens, the other from "U.-äker" is different; while Malloch (1924 *Psyche*, 31: pl. ix) has given some rather crude figures of the genitalia of a Swedish male sent to him by Ringdahl as *contractifrons* which I cannot make conform with either of the above or with *arctica*.

6. *L. (Spilogona) deflorata*, Holmgr., ♂♀. Plates XVI and XXIII.

1872. *Aricia deflorata*, Holmgren, Öfvers. Vetensk. Akad. Förh., 29: 102.

♂. Eyes separated by narrow silvery orbits which almost touch at narrowest part so that frons here is not so wide as third antennal joint. Frontal bristles not continued beyond a point as far in front of front ocellus as this is from hind ocelli. Cheeks, or facial orbits, silvery, slightly wider than frons at narrowest part. Face in profile very slightly concave, epistoma not projecting. Proboscis short and stout, theca mainly dusted greyish. Palpi black, dilated towards tip, hairy. Third antennal joint rather short, not reaching mouth-edge, arista distinctly pubescent, and not much thickened at base. Eyes with a few distinct pale hairs.

Thorax dull black on disc with perhaps a slight brownish tinge from all points of view except from right in front when there appears a very distinct greyish sheen. Humeri grey. The scattered dark pubescence moderately dense, hardly more than half length of bristles; four strong and distinct postsutural dorso-centrals. Scutellum black like thorax with a few tiny hairs on margin between, and on each side of, the apical bristles.

Abdomen ovate, rather broader at base than at tip, dorso-ventrally somewhat flattened, all dark seen from above, but from behind the black markings sharply defined on a light grey ground. First segment almost all dark; second with a pair of narrowly separated elongate patches extending whole length of segment and indented on outer side so as to somewhat resemble two letters YK set back to back; third segment with a pair of triangular dark patches on hind margin, the point of each reaching only about $\frac{2}{3}$ towards base of segment; side margins of 2nd and 3rd segments also darkened. Hypopygium greyish.

Middle femora with a postero-ventral row of bristles, longer and rather stronger towards base, much shorter and finer towards tip. Hind femora with 4-5 antero-ventral bristles towards tip, but quite short-haired postero-ventrally. Front tibiae without bristle behind. Middle tibiae apparently with no bristles other than apical, but in Holmgren's type there is a small bristle at middle behind. Hind tibiae with 2 antero-ventral and 2-3 antero-dorsal bristles, all short.

Wings slightly yellowish, costal ciliation short, bristles no longer than hairs. Squamae whitish. Halteres yellowish with knob somewhat greyish.

♀. A female incorrectly placed under *L. triangulara* in the Danish collection is almost certainly conspecific with the above male and was taken at the same place on the same day.

Interfrontalia (prolongation of ocellar triangle) very well differentiated, reaching to front of frons, brownish-grey when viewed from in front. Face hardly concave. Proboscis stout, theca lightly dusted greyish. Scutellum with setulae at tip as in male. Abdominal light brown patches large but ill-defined; fifth tergite with strong outstanding discal bristles. Middle femora with only 3-4 short bristly hairs at base beneath hardly so long as femur is thick. Hind femora quite short-haired postero-ventrally. Front tibiae without bristle behind. Middle tibiae with no distinct bristle in front and 2-3 small bristles in a

short row about middle behind. Hind tibiae with 2 antero-ventral, 3 antero-dorsal, and 2-3 smaller finer postero-dorsal bristles. Wings with yellow veins. Halteres yellow.

Length about 4 mm.

WEST GREENLAND : Tassiusak, 23.7.89 (*Lundbeck*), 1 ♂ 1 ♀.

I have been able to examine Holmgren's type and compare the genitalia with the specimen recorded by Lundbeck, and find that the latter author was undoubtedly correct in his recognition of Holmgren's species. The figures are from Lundbeck's specimen except that of the last abdominal sternite (fig. 6), which is from the type.

7. *L. (Spilogona) denudata*, Holmgr., ♂♀. Plates XVI and XX.

1869. *Aricia denudata*, Holmgren, K. svenska Vetensk. Akad. Handl., 8: 30.

1869. *Aricia ranunculi*, Holmgren, K. svenska Vetensk. Akad. Handl., 8: 34.

Small grey species superficially resembling *tornensis*, but with four post-sutural dorso-central, and shorter costal, bristles.

♂. Eyes separated on frons by less than width between posterior ocelli, the narrow silvery frontal orbits practically meeting at narrowest part of frons. Profrons in profile rounded, not prominent; epistoma only a little more projecting than profrons. Facial orbits of even width throughout, rather narrower than third antennal joint and silvery. Jowls rather deeper than third antennal joint is long, nearly $\frac{1}{3}$ vertical diameter of eye. Proboscis rather slender, theca dusted greyish.

Disc of thorax bluish-grey; when viewed from in front, much lighter grey with three narrow stripes down lines of bristles; when seen from behind, uniformly darker and faintly shining. Pleurae lighter or darker grey according to point of view.

Abdominal markings not very distinct or sharply contrasting with ground-colour, and somewhat varying in size according to point of view; ground-colour not very light grey; markings even when viewed from behind only brownish-black and then appearing largest, quadrate and narrowly separated on median line; viewed from above markings appear to merge into ground-colour. Fourth tergite apparently without markings. First sternite with 3-4 tiny bristles. Genitalia as figured, anal lamella (or upper forceps) of distinctive shape with the points converging.

Front tibiae without bristle behind; middle femora with almost complete row of long postero-ventral bristly hairs; middle tibiae with no bristle beneath, sometimes one smaller one in front, and 2-3 behind; hind femora with 5-6 antero-ventral bristles towards tip and no distinct long postero-ventral bristly hairs towards base though some short hairs may be present; hind tibiae with 3-4 antero-dorsal and 2 weaker antero-ventral bristles. Ungues and pulvilli rather long.

Wings very slightly tinted brownish, more so about base. Costal bristles small, about as long as costa is thick. Squamae whitish, thoracal nearly twice as long as alar and rounded at tip. Halteres yellow.

♀. Interfrontalia long continued practically to front of frons, dull grey and quite well differentiated from the two narrow wedge-shaped blackish divisions of the frontalia which it separates. Thorax grey with three faint narrow brownish stripes down lines of bristles and when viewed from behind some indication of four darker bluish-grey stripes between the bristles. Abdominal markings very faint and hardly visible; ovipositor with small curved spines beneath at tip. Chaetotaxy of legs much as in male but apparently postero-ventral row of bristly hairs on middle femora less complete.

Length about 4 mm.

WEST GREENLAND : Orpiksuit, 19.7.90 (*Lundbeck*), 1 ♂, included under the name *L. triangulifera* in the Danish collection. I have seen a second male from

W. Greenland among Malloch's paratypes of his *obsoleta* in the Academy of Natural Sciences of Philadelphia indicated by the letter "f" on label; a third from Nettilling Lake, Baffin Land, captured by J. D. Soper on July 9th, 1925, and submitted to me by Mr. H. C. Hockett of New York.

I have examined a male and female of Holmgren's types from Spitsbergen. The male genitalia in the specimen dissected show no apparent differences from the Greenland male except perhaps in outline of upper forceps (fig. 7a¹). The female is not unlike the specimen from Greenland I have placed under *deflorata*, but has a less marked abdomen, less pubescent arista and decidedly wider jowls below eyes; the spinose ovipositor appears to afford an additional distinctive character, though I cannot be certain of this owing to the hidden condition of the ovipositor in the female of *deflorata*. The three female types of *ranunculi*, Holmgr., are to my mind undoubtedly the same species as *denudata*, one without any trace of abdominal markings has distinct tiny bristles on first abdominal sternite such as are indicated in the *denudata* type male, and usual in this species; in the other females and the female of *denudata* the first sternite is concealed.

This species is placed in the Table under both 8 (15) and 15 (8) because it is not always easy to decide whether there are distinct postero-ventral bristly hairs to hind femora or not. I have re-examined the female from Spitsbergen recorded by me as *ranunculi* in 1924, *Ann. Mag. Nat. Hist.* (9) 14: 202, and which I referred to the group with hind femora long-haired postero-ventrally. In this specimen those hairs are not very long, and it appears to be correctly identified as *ranunculi* (= *denudata*). In all the females examined one of the smaller scutellar setulae is placed low down on side margin between the two strong bristles, which does not seem to be the case with females of *micans*.

8. *L. (Spilogona) macropyga*, Frey, ♂. Plates XV and XXI.

1915. *Limnophora macropyga*, Frey, Mem. Acad. Sci. Russ., 29: no. 10: 23, pl. i, figs. 5, 6.

A species with strongly produced epistoma uniformly blackish thorax bearing long fine bristles and long fine general pubescence, yellow halteres, a small bristle or two beneath middle tibiae, and no postero-ventral bristles about base of hind femora.

♂. Eyes somewhat widely separated on frons, at narrowest part equal to width of ocellar triangle, this latter a little shining in front of front ocellus. Frontal orbits rather narrow, glistening but not conspicuously silvery, narrower than frontalia; frontal bristles fine, continued back to opposite front ocellus. Facial orbits wide, distinctly wider than third antennal joint, silvery with blackish reflections. Jowls nearly $\frac{1}{3}$ vertical diameter of eye. Epistoma very square-ended in front. Third antennal joint hardly exceeding second in length, arista very microscopically pubescent, somewhat thickened for quite $\frac{1}{3}$ its length. No prominent facial keel between antennae. Proboscis rather slender, theca polished black.

Thorax black, faintly shining, even humeri only slightly greyish-black. Apparently four long fine postsutural dorso-ventrals normally, but my type has second from suture absent on the side. Scutellum with fine hairs continued low down on sides about tip.

Abdomen about same colour as thorax and apparently without distinct markings. Hypopygium with very long finger-like divisions of the anal lamella or superior forceps.

Legs black dusted greyish; front tibiae without bristle behind; middle femora about base with a row of 4-5 rather strong postero-ventral bristles about as long as femur is thick; middle tibiae with 1-2 distinct antero-dorsal, 1-2 small postero-dorsal, and at least one small

antero- and postero-ventral bristles; hind femora with 4-5 antero-ventral bristles on apical half, but no distinct postero-ventral bristles; hind tibiae with 2-3 antero-ventral, 1-2 antero-dorsal and 1-2 smaller postero-dorsal bristles. Tarsi long, ungues and pulvilli moderate.

Wings somewhat brownish especially towards base, but cross-veins not clouded; outer one rather more than its own length from middle cross-vein and quite one quarter longer than last section of postical vein. Costal bristles quite short. Squamae yellowish. Halteres yellow.

Length about 5 mm.

EAST GREENLAND: Hekla Havn, 30.7.92 (*Deichmann*), 1 ♂. Included by Stein among specimens of a "*Limnophora* sp.!" (No. 141 of "*Grönlands Landarthropoder*" 1917) consisting mainly of *hyperborea*, Holmgr. Frey's specimens were from the western side of Taimur Peninsula, Northern Siberia.

9. *L. (Spilogona) extensa*, Mall., ♂♀.

1920. *Limnophora extensa*, Malloch, Trans. Amer. Ent. Soc., 46: 150.

Mr. H. C. Hockett has kindly provided the following notes on the type male:—

♂. Eyes separated at narrowest by a distance equal to diameter of anterior ocellus; parafrontals [frontal orbits] contiguous, linear, frontal bristles fine continued in series caudad to a level with anterior ocellus; parafacials [facial orbits] equal in breadth to that of 3rd antennal joint, when viewed in profile; cheeks [my jowls] narrow, elongate, constricted caudad by the gradual upward curvature of caudo-ventral [occipital] margin; antennae separated by a rounded facial prominence; vibrissal angle produced beyond a level with base of antennae; proboscis polished.

Thorax viewed from above and in front, blackish with lightly brownish pruinescence; scutellum entirely blackish, subshining, presutural area of mesonotum paler [greyish] in colour, with a contrasting dark dorso-central vitta; border immediately adjoining transverse suture concolorous with postsutural area.

[Abdomen excised.] Legs with long fine bristles and setulae. Front tibiae with no posterior bristle; middle femora with fine antero- and postero-ventral bristles, the former shorter and weaker than the latter; middle tibiae with 1-2 posterior bristles, none in front or beneath. [Hind legs missing.] Calyptrae whitish. Halteres intensively darkened, paler about base.

♀. Frontal orbits brownish, narrower above than below, at middle almost as wide as third antennal joint and rather less than half width of frontalia; fine hairs outside frontal bristles rather long and distinct, irregularly biserial; interfrontalia very little differentiated, brownish, apparently reaching about halfway to front of frons; facial orbits and jowls often tinged with brown, the former considerably wider than third antennal joint, the latter rather deeper than that joint is long; epistoma in profile strongly projecting and truncate. Facial knob between antennae conspicuous. Proboscis with entirely shining theca. Disc of thorax and scutellum brownish, lighter on humeri and side margins, darker when viewed from behind, and in some lights with faint indications of four darker stripes of which the middle pair may appear fused into one when seen from behind. Scutellum not grey about middle. General pubescence rather long.

Abdomen brownish-grey without distinct markings; when viewed from in front or the side, it is dull and lighter in colour, from behind darker and slightly shining except perhaps about base and sides of tergites and on fourth tergite. There are long outstanding bristly

hairs on sides of first tergite, which spread more on to disc on second, and still more so on third and fourth tergites. Ovipositor with ovate hairy lamellae at tip and without spines.

Legs as in male, bristles and hairs long and distinct for a female especially on femora; hind femora with complete antero-ventral row of bristly hairs stouter towards tip, and long fine postero-ventral ones on basal half. Halteres darkened.

Length about 5 mm.

EAST GREENLAND: Cape Dalton, July 1900, 1 ♀ among series of so-called *triangulifera* in Danish collection.

WEST GREENLAND: three female paratypes out of six in the Academy of Natural Sciences, Philadelphia; the other three (indicated by letters d, e, and f on labels) being *sanctipauli*, Mall.

The female of *megastoma* which resembles *extensa* in many characters has no distinct keel between antennae, theca of proboscis dusted about base beneath, scutellum grey on middle, abdominal dark patches more distinct, rather more distinct costal ciliation, and yellow halteres. The female of *sanctipauli* has no raised keel between antennae, thorax grey with indications of three darker stripes down lines of bristles instead of between them, and legs with less conspicuous bristles and bristly hairs on femora, especially shorter on hind femora postero-ventrally.

It should be noted that Malloch described the type as having two antero-dorsal bristles to middle tibiae, while Hockett says there are none. Malloch also said the male had "a few short bristly hairs" postero-ventrally on basal half of hind femora; in at least the females these hairs are distinctly long. The genital parts figured by Malloch (anal lamella or upper forceps and side lamella) much resemble those of *deflorata*.

10. *L. (Spilogona) hyperborea*, Bohem., ♂♀. Plates XV and XXII.

- 1865. *Aricia hyperborea*, Boheman, Öfvers. Vetensk. Akad. Förh., 22: 571.
- 1865. *Aricia labiosa*, Boheman, Öfvers. Vetensk. Akad. Förh., 22: 571.
- 1869. *Aricia dorsata*, Holmgren (*nec* Zett.), K. svenska Vetensk. Akad. Handl., 8: 29.
- 1869. *Aricia fuliginosa*, Holmgren, K. svenska Vetensk. Akad. Handl., 8: 30.
- 1869. *Aricia conspurcata*, Holmgren, K. svenska Vetensk. Akad. Handl., 8: 31, ♂.
- 1869. *Aricia illota*, Holmgren, K. svenska Vetensk. Akad. Handl., 8: 32.
- 1920. *Limnophora frigida*, Ringdahl, Ent. Tidskr., 41: 27.
- 1920. *Limnophora pearyi*, Malloch, Trans. Amer. Ent. Soc., 46: 151.

This species agrees in so many respects with the description of *latilamina* that it is unnecessary to do more than point out the differences.

♂. Eyes not quite so much separated on frons. Jowls rather narrower. Epistoma more distinctly produced. Arista not quite so much thickened and slightly more pubescent. Proboscis polished, not dusted. Thorax without indications of darker stripes. Scutellum with hairs descending lower on to lateral margins towards tip. Abdominal dark patches still less defined especially towards sides. First sternite without any tiny hairs. Front tibiae usually with bristle behind. Middle femora with 3-4 stronger bristles postero-ventrally. Cross-veins slightly further apart. Halteres usually dark.

♀. Head more brownish especially on frontal orbits; interfrontalia more differentiated and brown. Thorax not so grey in front and behind and on scutellum. Abdomen more extensively brownish. Tip of ovipositor without tiny spines beneath. Front tibiae with distinct bristle behind.

Length variable, normally 5-6 mm., but occasionally only 3-75 mm.

EAST GREENLAND: Hekla Havn, 7 ♂ 8 ♀. Cap Dalton, 3 ♂ 4 ♀. "Grönland Mus. Staeg," 1 ♂ 1 ♀. Mainly "*Limnophora* sp!" No. 141 of "Grönlands

Landarthropoder," 1917, but some included under *triangulifera* by Stein and one labelled "*L. compuncta*, Wdm. H. Kramer det."

I have compared the male genitalia of a cotype of Ringdahl's *frigida*, specimens which I had identified as *hyperborea* from Spitsbergen, a small male from Nettiilling Lake, Baffin Land, communicated by Mr. H. C. Hockett of New York, and some of the above specimens from Greenland, and find them all identical in structure.

Mr. Hockett has kindly supplied notes on the type male of Malloch's *L. pearyi*, and I have been able to examine the female allotype and a male paratype. This last is a specimen of the species Mr. Hockett has identified as *L. sanctipauli*, Mall., but the female allotype is certainly, and the male type probably, the same as my *hyperborea*, Bohem.

I have examined the types of Holmgren's Spitzbergen species *dorsata* (Zett.), *fuliginosa*, *conspurcata* and *illota* and dissected out the genitalia of one male of each to find that they are all only small specimens of *hyperborea*, Boh. In the type of *illota* the right wing has an adventitious cross-vein between the subcostal and radial veins and another just beyond this between the radial and cubital veins.

I have also been able to examine Boheman's types from Spitsbergen (a pair on one pin) and compare the genitalia with those figured and find the identification correct.

Holmgren was probably correct in placing *labiosa*, Boh., under this species. The type (a somewhat immature female) possesses all the characters of *hyperborea*, though the frontal bristles are rather more numerous and the cross-veins show scarcely a trace of clouding. Another probable synonym is *L. birulae*, Frey (*Mem. Acad. Sci. Russ.*, 1915 : 22, pl. i, figs. 3, 4).

11. *L. (Spilogona) latilamina*, sp. n., ♂♀. Plate XV.

A species having most of the characters of *brunneisquama*, Zett., but of narrow build with rather wider jowls, whiter squamae and larger, less strongly contrasting abdominal markings.

♂. Eyes separated on frons at narrowest by narrow grey orbits and equally narrow black frontalia so that it is rather wider than space between posterior ocelli. The pointed extreme front of ocellar triangle shining. Facial orbits almost equal in width to that of third antennal joint. Jowls much wider (about $\frac{1}{3}$ vertical diameter of eye) with upcurved bristles of *brunneisquama* represented by only fine hairs. Third antennal joint only slightly longer than second; arista microscopically pubescent, strongly thickened on basal third. Facial keel between antennae only very slightly raised. Epistoma in profile very little more produced than profrons. Proboscis not very stout, theca thinly dusted greyish.

Disc of thorax dull greyish-black seen from in front, much darker and slightly shining viewed from behind with some indications of three darker stripes on presutural area; humeri and notopleural region grey. Pleurae grey or blackish in patches according to point of view. Four postsutural dorso-central bristles; acrostichals multiserial, fine, and not very long.

Abdomen very little dorso-ventrally flattened; 1st tergite all dark except for extreme hind margin; 2nd with large dark patches occupying practically whole length of tergite, very indistinctly separated on median line and only a little wider on hind margin than at base, thus forming an almost quadrate patch; 3rd tergite with similar patches but narrower in proportion to length; 4th darkened for practically whole length down middle, the patch longer than wide; lighter parts at sides of tergites somewhat whitish grey, most distinctly so when viewed from behind; these grey parts disappear when abdomen is viewed from side and

whole abdomen appears dark except for indistinct median stripe and extreme basal and hind margins of segments. First sternite usually with 1-2 tiny hairs.

Front tibiae without bristle behind; middle femora with a row of 4-6 not particularly strong postero-ventral bristles; middle tibiae with 1-2 small antero-dorsal, 2-3 postero-dorsal, 1-2 larger or smaller antero-ventral and 1-2 similar postero-ventral bristles; hind femora with not very long antero-ventral bristles on apical half only and no distinct postero-ventral bristles; hind tibiae with 3-4 antero-ventral, 2 antero-dorsal, and 2 postero-dorsal bristles, these last the smallest. Claws and pulvilli moderate.

Wings distinctly brownish about base, the colour spreading along costal half, and faintly clouding outer cross-vein; cross-veins very little more than length of outer one apart, last section of postical vein slightly shorter than outer cross-vein. Squamae whitish with pale yellow margins. Halteres yellow.

♀. Frons with the rather narrow greyish orbits only a little brownish towards junction with wide frontalia; interfrontalia very little differentiated in colour but faintly shining and extending rather more than half way to front of frons; hairs outside frontal bristles short and fine and hardly more than uniserial. Almost silvery facial orbits considerably wider than in male. Second antennal joint slightly shorter in proportion to third. Proboscis as usual rather stouter.

Disc of thorax greyer and especially less black when viewed from behind; appearing broadly brownish from in front with two narrow greyish stripes in front and behind as well as grey humeri, notopleural depression, extreme front of thorax, and scutellum towards tip. Abdomen grey with vague brownish patches indistinctly separated on median line. Ovipositor yellowish about tip and with small black spines beneath last sclerite. Legs very much as in male but usually a fine bristle behind front tibiae. Wings not so brownish and with cross-veins rather wider apart.

Length about 5.5 mm.

EAST GREENLAND: Hekla Havn, 30.7.92 (*Deichmann*), 2 ♂ 3 ♀, labelled *Limnophora* sp. ! by Stein (No. 140 in "Grönlands Landarthropoder" 1917).

The male genitalia of this species shows marked resemblance to the figures given by Schnabl for his *L. zaitzevi*,* that species, however, has the epistoma produced and would appear to have narrower jowls while Schnabl makes no mention of the presence of bristles beneath the middle tibiae. *L. cilifera*, Frey, 1915 (*Mem. Acad. Sci. Russ.*, 29: 24, pl. i, figs. 7, 8), is probably the same as *zaitzevi*.

L. hyperborea, which is superficially very much like *latilamina*, may be distinguished in both sexes by its more strongly produced epistoma and entirely shining proboscis.

***L. (Spilogona) macropyga*, Frey. (v. No. 8, p. 263.)**

12. *L. (Spilogona) malaisei*, Ringd. Plates XVI and XXIII.

1920. *Limnophora malaisei*, Ringdahl, Ent. Tidskr., 41: 29.

A small dark species with abdomen of female seen from behind unicolorous and shining.

♂. Head deeper than long with epistoma only slightly produced. Eyes separated at narrowest part of frons only by the narrow silvery orbits. Facial orbits silvery, hardly so wide as third antennal joint. Jowls quite twice as wide. Arista only microscopically pubescent. Proboscis rather slender, polished, not dusted.

Thorax and scutellum dull blackish with a brownish-grey tinge in some lights, especially

* 1915, *Mem. Acad. Imp. Sc. Petrograd*, 27: Pl. xi, figs. 17, 18.

when viewed from in front, and not greyer on humeri. Four postsutural dorso-centrals. Scutellar hairs continued lower down than usual on margin towards tip.

Abdomen very dark greyish with the black markings very indistinct except when viewed from behind, then whole of first, and nearly whole of second tergite (except for a narrow central stripe and the convex side margins), black; third tergite with a pair of black patches rather more widely separated than on second tergite, extending whole length, and widening out along hind margin; fourth tergite viewed immediately from behind with indications of a pair of elongate triangular black patches on hind margin.

Legs black; front tibiae without bristle behind; middle femora with only short hair-like bristles postero-ventrally about base; middle tibiae with 2 small postero-dorsal and occasionally one small antero-dorsal; hind femora without distinct postero-ventral bristles towards base and only 3-4 antero-ventral towards tip; hind tibiae with 2 antero-ventral and antero-dorsal bristles and usually one postero-dorsal.

Wings slightly brownish with short and inconspicuous costal ciliation. Squamae and halteres yellow.

♀. Not quite so dark (a little more greyish-brown) than male. Frontal orbits brownish, narrower at vertex than towards front and here half width of frontalia. Abdomen viewed from behind unicolorous shining blackish, from other points of view more dull and dusted brownish. Ovipositor without spines beneath at tip. Wings clearer and costal bristles a little coarser than in male.

Length about 3.5 mm.

EAST GREENLAND: Hekla Havn (*Deichmann*), 9 ♂ 7 ♀, labelled "*Limnophora* sp.!" by Stein (No. 142 in "Grönlands Landarthropoder" 1917).

WEST GREENLAND: Kugssuk, Godthaab Fj. (*Maj. Hingston*, Oxford Univ. Exp. 1928), 2 ♂ 3 ♀.

The male genitalia have been compared with those of a cotype of Ringdahl's *L. malaisei* from Vassigaure in Lappland and found to be the same.

13. *L. (Spilogona) megastoma*, Bohem., ♂♀. Plates XV and XIX.

1865. *Aricia megastoma*, Boheman, Öfvers. Vetensk. Akad. Förh., 22: 572.

1869. *Aricia ludibunda*, Holmgr., K. svenska Vetensk. Akad. Handl., 8: 32.

1869. *Aricia pauxilla*, Holmgr., K. svenska Vetensk. Akad. Handl., 8: 32.

♂. Eyes separated on frons rather wider than width of third antennal joint, orbits narrow, frontal stripe at narrowest point almost double width of one orbit. Frontal bristles continued upwards to point opposite front ocellus. Facial orbits as wide as third antennal joint and of almost equal width throughout. Epistoma distinctly but not strongly projecting. Proboscis rather slender, theca shining except at base beneath.

Thorax dull grey viewed from in front, very much darker (except on humeri) when viewed from behind, scutellum especially (even when seen from side) dull black, only greyish at tip beneath. Prehypopygial tergite with long down-curved bristly hairs.

Middle femora with an antero-ventral row of rather long fine hairs on basal half, as well as the complete postero-ventral row of bristles which are very long on basal half but much shorter and finer towards tip. Antero-ventral row of bristles on hind femora also practically complete but bristles shorter and finer towards base, postero-ventral bristles on basal half long and distinct. Tibial bristles rather variable in number and strength. Middle tibiae usually with 2-3 long bristly hairs at middle behind, often not placed in line (one being more postero-ventral), and sometimes a small one in front. Hind tibiae with 2 antero-ventral, 2-3 often fine antero-dorsal and 1-3 longer finer postero-dorsal. Wings with rather strong dark veins. Halteres dark.

♀. Frontal orbits brownish, sparsely haired; interfrontalia very indistinct. Proboscis a little stouter than in male.

Thorax darker (brownish) on middle of disc with indications, often quite distinct, of four narrow darker stripes, inner pair between rows of dorso-centrals, outer stripe rather wider, outside dorso-centrals and distinctly interrupted at suture. Scutellum grey about middle line. Ovipositor with long-haired ovate terminal papillae and no spines. Halteres yellow. Length about 4 mm.

EAST GREENLAND : Hekla Havn (*Deichmann*), 8.91, a pair; 17.6.92, a pair; 28.7.92, 1 ♂; 30.7.92, 1 ♀. Cape Dalton 7.1900, 2 ♂, included in the series under the name of *L. triangulifera*, Zett., in the Danish collection.

This species must be closely related to *triangulifera*, Zett., as elucidated by Ringdahl. The male genitalia of the two species are very similar and so is the chaetotaxy of the legs. It is, however, a much greyer species than *triangulifera*, with a broader frons in male, and has thicker wing-veins. The theca of proboscis is also not so extensively dusted, the facial keel between the antennae not quite so distinct and the costal ciliation of wings rather stronger. I have examined a pair of Holmgren's specimens of *megastoma* from Spitsbergen and consider them the same species as described above, also two type males of *ludibunda*, Holmg., from Advent Bay, Spitsbergen; a dissection of the genitalia of one of them shows no differences from those figured for *megastoma*.

I have examined the types of *pauvilla*, Holmgr., the only male has unfortunately lost its abdomen; it is also in poor condition, the head distorted and two hind legs (obviously of two distinct species) gummed on to the body; a careful comparison of this specimen with males of *megastoma* has convinced me that they are not distinct. The somewhat more pointed lower outer corner of discal cell is more evident in one wing than in the other and probably only a variation. A female also agrees with females of *megastoma* except for the same variation. A female of Holmgren's *conspurcata* is not *hyperborea* like its male, but a female of *megastoma* of this *pauvilla* form.

It appears probable that Boheman had two distinct species before him when he described *megastoma*, for he wrote of the male "ano tuberculis 2 rotundatis nitidissimis instructo," a character which *megastoma* as generally recognised does not possess; nor is there a specimen answering to this description among the types sent to me from Stockholm (two females and one male, the latter labelled "*megastoma videtur*"), these agree with the species I have described above to which the name *megastoma* has been restricted by Holmgren and subsequent authors. Holmgren considered that Boheman had included *hyperborea* under the name *megastoma*, but the male hypopygium is not shining in *hyperborea*.

Frey's *megastoma* (1915, *Mem. Acad. Sci. Russ.*, 29: 27, pl. ii, figs. 19, 20), is not the species described above, but the same as my *sanctipauli*. Frey also figures the genitalia of a species quite distinct from either of these (which he places in the genus *Limnaricia*, Schnbl.) as *pauvilla*, Holmgr.

14. *L. (Spilogona) micans*, Ringd., ♂♀. Plates XV and XX.

1918. *Limnophora micans*, Ringdahl, Ent. Tidskr., 39: 156.

♂. Eyes only separated on frons by the narrow silvery orbits. Face short, slightly concave in profile, epistoma not produced. Antennae short. Proboscis with theca dull dusted greyish.

Disc of thorax viewed from in front bluish-grey, with space between rows of dorso-centrals, and scutellum, much darker; viewed from behind whole disc except in front darkened and this presutural area with tendency to be darker between the rows of dorso-centrals and with one or three narrow darker stripes continued to front margin. Pleurae

more dull black. General pubescence rather long; four postsutural dorso-centrals (in this particular specimen four on one side, five on other). No setulae on scutellar margin.

Abdomen with large indefinite dark markings having base towards sides of segments rather lighter grey. First segment nearly all dark; second with patches extending whole length towards middle line, and spreading along hind margin right to sides, only indistinctly separated on median line by a rather lighter brown stripe; third segment similar, but patches rather smaller and more distinctly separated on middle line; fourth with median patch on hind margin spreading up middle almost to base of segment.

Front legs missing. Middle femora with a postero-ventral row of long bristly hairs continued (but becoming shorter) for $\frac{3}{4}$ length of femur; these femora also rather more distinctly hairy and bristly in front than usual; hind femora with long postero-ventral bristly hairs on basal half—longer than femur is thick, and 4–5 antero-ventral strong bristles towards tip; middle tibiae with two small bristles behind only; hind tibiae with one antero-ventral, and two antero-dorsal bristles.

Wing-veins not thickened. Squamae white. Halteres darkened.

♀. Interfrontalia indistinct but large and long reaching almost to front of frons, seen from above very little contrasted in colour, but seen from in front rather more golden-brown than rest of frons. Frontal orbits about as wide as third antennal joint and bearing in addition to frontal bristles rather conspicuous short bristly hairs arranged in two irregular rows. Facial orbits almost as wide but jowls quite twice as wide as third antennal joint. Face decidedly concave. Theca of proboscis dusted.

Thorax greyer than in male, but with similar though less intense darker markings. Presutural acrostichals fine and practically only biserial though there are a few others close to dorso-centrals.

Abdomen grey with faint ill-defined but rather large light brownish markings which appear slightly shining when viewed from behind; fifth tergite with long, outstanding, discal, bristly hairs, even longer than the more depressed marginal ones. Terminal lamellae of ovipositor small, not projecting beyond end of last ventral sclerite, which bears some strong upcurved black spines.

Legs dusted greyish; no bristle behind front tibiae; middle legs missing; four to five long postero-ventral bristly hairs about base of hind femora; hind tibiae with 1–2 very small antero-ventral and two small antero-dorsal bristles. Wings and squamae as in male, but halteres yellow.

Length about 4.5 mm.

EAST GREENLAND: Hekla Havn, 15.7.92 (*Deichmann*), 1 ♂ (included among series of so-called *triangulifera* in Danish collection), and Hekla Havn, 30.7.92 (*Deichmann*), 1 ♀ (included under L. No. 142 of "Grönlands Landarthropoder" 1917).

Through the kindness of my friend Mr. Ringdahl of Halsingborg I have been able to compare the above male with the type specimen from Gällivara—a specimen in better condition and more mature than the Greenland one. They are certainly the same species, though in the type the general pubescence of thorax is rather shorter and more scanty, presutural part of thorax still more distinctly greyish, legs generally not quite so long-haired, five rather more differentiated postero-ventral bristles on middle femora, and 2–3 small antero-ventral bristles to hind tibiae. The genitalia are almost identical, with perhaps some slight difference in the shape of the anal lamella or upper forceps (fig. 14a¹); as, however, the last sternite is obviously slightly malformed in the type, the anal lamella may easily have been somewhat affected from the same cause.

Frey's figures of the genitalia of his *L. pumilio* (1915, *Mem. Acad. Sci. Russ.*, 29: 27, pl. ii, figs. 17, 18), show considerable resemblance to those of

micans, but there are small differences, and the male halteres are described as "yellow."

15. *L. (Spilogona) monacantha*, sp. n., ♂♀. Plates XVI and XXI.

♂. Eyes separated on frons at middle only by the narrow silvery orbits, tiny triangle in front of front ocellus shining. Face only slightly concave, epistoma not produced. Facial orbits not so wide as third antennal joint, jowls deeper than that joint is long. Antennae short, third joint hardly $1\frac{1}{2}$ times length of second. Arista microscopically pubescent. Proboscis with theca shining, not very stout. Thorax light grey on disc, rather darker viewed from behind with three slightly darker narrow stripes down lines of bristles. Scutellum blackish with tip grey beneath. Four postsutural dorso-centrals; acrostichals fine, quadriserial in front, an additional row of similar hairs close to presutural dorso-centrals.

Abdomen grey with rather large distinct dark patches. Basal segment dark except at sides and on extreme hind margin; second segment with large quadrate patches very nearly reaching hind margin and only narrowly and indistinctly separated on middle line, grey sides extending inwards on front margin about $\frac{1}{3}$ width of abdomen; third segment with similar large patches, fourth with large patch occupying whole width of hind margin, and reaching front margin in a point.

Legs with no bristle behind front tibiae; a stout postero-ventral spine near base of middle femora; 1 short bristle in front and 2-3 behind middle tibiae; no postero-ventral bristly hairs to hind femora, but on one femur only there is a spine-like bristle beneath similar (but less strong) to that on middle femora and placed rather further from base; hind tibiae with 3 antero-ventral, 2 antero-dorsal and 2 postero-dorsal bristles.

Wings clear; outer cross-vein rather more than its own length from middle cross-vein and half its length from wing-margin at its lower end. Costal ciliation short. Squamae pale yellowish-white, large and rounded. Halteres yellow.

♀. Frontal orbits brownish, about width of third antennal joint; interfrontalia continued even if narrowly almost to front of frons; facial orbits rather wider than in male especially above; third antennal joint rather larger. Thorax with three more distinct brown stripes down lines of bristles. Scutellum with median grey stripe. Abdomen with large distinct brownish patches; ovipositor spinose.

Legs often with no bristle in front of middle tibiae and only 1-2 small postero-dorsal bristles to hind tibiae. No distinct bristle beneath base of middle femora, and no bristly hairs postero-ventrally. Outer cross-vein usually further from wing-margin, but variable.

Length about 6 mm.

WEST GREENLAND: A pair taken at Umanak, 26.7.14, by the Crocker Land Expedition communicated by Mr. H. C. Hockett of New York. Two females under the name *L. contractifrons* in the Danish collection from Kangarsunek, 22.7.90.

16. *L. (Spilogona) obsoleta*, Mall., ♂♀. Plates XVI and XIX.

1920. *Limnophora obsoleta*, Malloch, Trans. Amer. Ent. Soc., 46: 149.

Mr. H. C. Hockett has kindly supplied the following notes on the male type of this species:—

♂. Thorax and abdomen entirely chocolate brown, opaque. Eyes separated at narrowest by a distance equal to twice that between posterior ocelli. Thorax with longish accessory setulae. Dorso-central bristles fine. Tibiae short, setulose, with fine weak bristles. Middle tibiae with 2-3 fine ventral bristles. Wings with numerous erect costal spines. Antennae separated at base by an inconspicuous facial ridge. First abdominal sternum bare.

I have not seen the type, but through the kindness of the Curator of the Academy of

Natural Sciences of Philadelphia I have been able to examine all the paratype material as well as the allotype female.

One male paratype (indicated by an "f" on label) is *denudata*, Holmgr., but a second specimen is certainly identical with the type though it has the frons rather wider even than stated by Hockett, as wide as in *alpica* and rather wider than the short third antennal joint is long. Proboscis distinctly stout, theca slightly dusted greyish. Face smoky-black, and particularly the "lunula" between base of antennae and frontal suture blackish. Pleurae blackish. Abdomen faintly shining in some lights, practically unicolorous. Middle femora with a postero-ventral row of 5-6 long bristles on basal half. Middle tibiae without bristle in front but with one behind (rather postero-ventral) and two antero-ventral. Hind femora with antero-ventral row almost complete, but bristles on basal half much shorter; postero-ventrally with 3-4 bristles towards base shorter than femur is thick. Wings brownish about base and on costal half. Halteres dusky brown.

The male in the Danish collection is immature and has the frons contracted and thus apparently much narrower, but otherwise agrees so well with the above that I have no doubt it is Malloch's species.

♀. As usual, rather larger and lighter coloured than male. Frontal orbits broad, somewhat golden-brown and with small bristly hairs outside row of frontal bristles arranged in more than single row. Frontalia narrow, more than $\frac{1}{3}$ but less than $\frac{1}{2}$ width of frons, of similar colour to orbits except when viewed from behind and with no distinct interfrontalia unless it is so large as to occupy almost all frontalia. Proboscis very stout and broad. Lunula darkened as in male.

Disc of thorax brown with this colour inclined to form three stripes, but when viewed from behind these stripes disappear and four narrow darker stripes become visible, of which the middle pair are most persistent in front of suture. Scutellum and pleurae much greyer than in male.

Abdomen light brown with basal and hind margins of each segment greyer, the brown part somewhat shining from some points of view.

Legs as in male, but middle tibiae with two bristles in front and behind as well as the antero- and postero-ventral ones. Postero-ventral bristles on hind femora usually quite as distinct as in male. Halteres yellow.

Length about 4.25 mm. ♂; 4.75 mm. ♀.

EAST GREENLAND: Hekla Havn, 30.7.92. (*Deichmann*), 1 ♂, included under the name *L. triangulifera* in Danish collection.

WEST GREENLAND: (Malloch's cotypes), 1 ♂ 5 ♀.

I have not been able to examine the male genitalia of West Greenland (topotypical) specimens, but have compared those of the East Greenland male and a male from Savonoski, Naknek Lake, Alaska, taken by Mr. Jas. S. Hine in June 1919, and sent to me by Mr. H. C. Hockett. As can be seen in the figures these exhibit considerable differences in the shape of the side lamellae and some slight difference in the shape of the anal lamella or superior forceps. The other figures might serve for the respective parts of either species, and the insects themselves are so much alike that I suspect the differences to which I have called attention are merely accidental. It is quite possible, however, that there may be two closely allied species, a point which can be settled only by the examination of a greater amount of material. The American specimen is represented in figure 16*b*, the Greenland specimen by the other figures under the number 16.

17. *L. (Spilogona) opaca*, Schnbl., ♂♀. Plates XVIII and XX.

1915. *Limnophora (Spilogona) opaca*, Schnabl, Mem. Acad. Imp. Sci. Petrograd, 38: 28, pl. figs. 21, 22 and 57.

1918. *Limnophora freyi*, Ringdahl, Ent. Tidskr., 39: 150.

♂. The male before me is rather immature and the frons is contracted and not normal; probably it should be about as wide as ocellar triangle with silvery orbits. Eyes slightly pubescent, frontal bristles continued upwards to front ocellus; facial orbits not so wide as third antennal joint; jowls about as long as that joint. Epistoma not produced. Proboscis rather stout, theca dusted greyish.

Thorax viewed from in front with disc brownish-black, grey in notopleural depression, on humeri and right in front including indications of two narrow grey median stripes; seen from behind the disc is blacker and faintly shining and the two grey stripes mentioned above are continued down thorax, but are here only slightly less black than rest of disc. Four postsutural dorso-centrals. Pleurae grey with blackish reflections. Scutellum black.

Abdomen extensively brownish-black seen from above, but from behind the black patches show up distinctly on a greyish ground; first tergite mainly dark with greyish hind margin and indistinctly so on middle line; second tergite with long narrow patches slightly wider on hind margin than in front, and rather widely separated; third with more triangular patches, and fourth with dark median stripe. First sternite with a few bristles.

Legs with no bristle or only a fine one behind front tibiae; middle femora with 5-6 long postero-ventral bristly hairs on basal half and some much shorter antero-ventral ones; middle tibiae with one bristle in front and 2-3 behind but none beneath; hind femora with practically complete antero-ventral row of bristles (shorter and more hair-like on basal half) and 5-6 long postero-ventral bristly hairs on basal half; hind tibiae with 2-3 antero-ventral, 2 antero-dorsal and 1-2 small postero-dorsal bristles. Wings not darkened, with extremely short costal ciliation, last section of postical vein hardly more than half length of outer cross-vein. Squamae large, yellow. Halteres bright yellow.

♀. Frontalia wide, frontal orbits only from $\frac{1}{3}$ to $\frac{1}{4}$ as wide, grey with brown border next to frontalia; interfrontalia greyish-brown continued slightly beyond middle. Facial orbits silvery, wider than third antennal joint above but narrower below. Jowls hardly as deep as third antennal joint is long. Proboscis as usual rather stouter than in male.

Thorax broadly brown across middle where a narrow middle stripe and broad side stripes coalesce, the broad side stripe may indistinctly split into two behind suture. Scutellum grey with brown base.

Abdomen with rather distinct brownish patches which are slightly shining when viewed from behind, larger and more trapezoid on second, smaller and more triangular on third tergite. Ovipositor without spines.

Middle tibiae more often with two bristles in front, and femoral bristles shorter (except for 2-3 antero-ventral near tip of hind femora) than in male.

Length 5-6 mm.

WEST GREENLAND: Auleitsivik (Nordskj. Exp. '83), 1 ♀, wrongly included under *trigonifera* in Danish collection. Kugssuk, Godthaab Fj. (Maj. Hingston, Oxford Univ. Expedition 1928), 1 ♀.

A comparison of the male genitalia of a cotype of Ringdahl's *L. freyi* with Schnabl's figures of those of his *opaca* leaves little doubt that the two names represent the same species.*

Though it is admittedly difficult to recognise females in this genus, I feel certain that the identification of these two Greenland females is correct, especially as my friend Ringdahl has seen Major Hingston's specimen and confirmed its identity with *freyi*.

* It should be noted that in Schnabl's paper the description of the male hypopygium of *opaca* is misplaced; it appears on p. 30 after the description of the male of *seticosta* instead of at the end of the description of *opaca* on p. 29.

18. *L. (Spilogona) sanctipauli*, Mall., ♂♀. Plates XVI and XXIII.

1915. *Limnophora megastoma*, Frey, nec Boheman, Mem. Acad. Sci. Russ., 29 : 27, pl. ii, figs. 19, 20.
 1921. *Limnophora sanctipauli*, Malloch, Proc. Calif. Acad. Sc., 11.
 1898. *Limnophora triangulifera*, Lundbeck, nec Zetterstedt, Vidensk. Medd. naturh. Foren. Kjob., 1898 : 312.

♂. Resembling the Swedish *triangulifera*, Zett., of Ringdahl, but eyes rather more widely separated on frons, at narrowest part about as wide as third antennal joint. Facial orbits also wider (slightly wider than frons). Epistoma slightly more produced. Fewer upcurved hairs at sides of peristoma and rather less dense postocular ciliation. Antennae short, arista microscopically pubescent. Proboscis with theca polished, whereas in *triangulifera* it is dusted greyish.

Thorax not so dark, and general pubescence not quite so dense. It is greyer on disc with indications of three brownish-black stripes which coalesce behind, whereas in *triangulifera* there are indications of four darker stripes. Viewed from behind thorax appears darker. Scutellum blackish, hairs not continued down on to sides towards tip. Pleurae not so black. Four (occasionally only 3) postsutural dorso-centrals.

Abdomen very similar in both species; first tergite largely dark; second with large, and third with smaller, triangular dark markings; fourth indistinctly darkened on middle towards hind margin. Ground-colour greyish, and markings well contrasting.

Legs with similar bristly hairs antero- and postero-ventrally to middle femora as in *triangulifera*, but apparently these femora not so long-haired behind; hind femora shorter-haired postero-ventrally towards base, hairs not so long as femur is thick; middle tibiae with 1-2 bristles in front as well as behind.

Wings somewhat brownish, especially towards base. Squamae white. Halteres dusky.

♀. Frontal orbits wide, more than half width of frontalia, but narrower towards vertex, not much darkened and bearing only a few scattered hairs in addition to usual frontal bristles. Facial orbits also wide, at narrowest as wide as third antennal joint. Jowls rather deeper than that joint is long.

Thorax brownish-grey on disc, humeri and side margins lighter grey. Indications of 3-5 brownish stripes down lines of bristles, with, in some lights, on extreme front between rows of dorso-centrals, a narrow dark stripe on each side of the median brown stripe. Scutellum grey on disc, brownish at sides.

Abdomen grey with faint brownish patches on hind margins of 2nd and 3rd tergites, which do not reach front margin but spread along towards sides. First tergite largely brownish in some lights and last tergite brownish towards tip in some lights. Terminal lamellae of ovipositor ovate, hairy.

Front tibiae without bristle behind; middle and hind legs much as in male, but bristles rather shorter; hind tibiae with 1-2 antero-ventral, 2-3 antero-dorsal, and 1-2 postero-dorsal short bristles.

Wings clearer. Halteres only greyish-yellow.

Length 4.5-5 mm. Females sometimes larger.

EAST GREENLAND : Hekla Havn (*Deichmann*), 14 ♂ 7 ♀; Cape Dalton, July 1900, 13 ♂, 2 ♀.

WEST GREENLAND : Orpiksuit, 1890, 1 ♂ 3 ♀; Auleitsivik (Nordskj. Exp. '83), 3 ♀; Ritenbenk, 2.9.90, 1 ♀; Egedesminde, 10.7.90, 1 ♀; Har-ön (Nordskj. Exp. '83), 1 ♀. Kristianshaab, 1890 (*P. Müller*), 1 ♀; Kugssuk, Godthaab Fj. 13.6.28 (*Maj. Hingston*), 1 ♀.

Most of these specimens stood under the name *triangulifera* in the Danish collection, though a few females were included under *contractifrons* (= *arctica*).

There are also some specimens in the Academy of Natural Sciences, Philadelphia, from the West Coast of Greenland, taken by the Peary Expedition in 1891; viz. one male paratype of *L. pearyi*, Mall., and three female paratypes of *L. extensa*, Mall. Mr. H. C. Hockett called my attention to the identity of these specimens with *sanctipauli*, Mall., and also sent for my examination further examples of what proved to be this species:—a male from Cape Hatherton, N. of Etah, Greenland, taken by the McMillan Expedition, August 1925; a male from Umanak, Greenland, by the Crocker Land Expedition, and 1 ♂ 2 ♀ from Nettiiling Lake, Baffin Land, captured by J. D. Soper, 9.7.25. In fig. 18 *b*, a figure of the tip of the side lamella is given showing the alteration in outline when the lamella is slightly tilted to one side.

19. *L. (Spilogona) semiglobosa*, Ringd. Plates XV and XXI.

1916. *Limnophora semiglobosa*, Ringdahl, Ent. Tidskr., 37: 236.

Very much like *monacantha* but thorax darker, abdominal spots smaller and narrower and middle femora with the single spine beneath near base in both sexes.

♂. Compared with *monacantha* the third antennal joint rather longer, jowls not so deep as that joint is long, bristles near vibrissae and along mouth-edge shorter and less numerous. Thorax viewed from in front dull brownish-grey, with a narrow grey stripe each side of acrostichals and grey in front, on humeri and in notopleural depression, but viewed from above darker and slightly shining with black sides about root of posthumeral bristle and between supra-alar and intra-alar bristles. Abdomen extensively darkened when viewed from above, but from behind, light grey with smaller, narrower dark patches than in *monacantha*. Chaetotaxy of legs as in that species, hind femora with no spine beneath or postero-ventral bristly hairs.

♀. Apparently differing from *monacantha* chiefly in having a small spine beneath middle femora near base similar to that of males, and thorax more uniformly brown owing to thoracic stripes becoming confluent behind suture.

EAST GREENLAND: Hekla Havn, 30.7.92 (*Deichmann*), 1 ♀.

This female would appear to be *semiglobosa*, possessing as it does the characters mentioned above, but there must remain some doubt concerning the addition of this species to the Greenland fauna until a male has been taken. I have been able to figure the differences in the male genitalia between this species and *monacantha* owing to the kindness of my friend Mr. Ringdahl in allowing me to dissect a male taken by him at Narvik in Norway.

20. *L. (Spilogona) tornensis*, Ringd., ♂. Plates XVI and XXII.

1920. *Limnophora seticosta*, Ringdahl (*nec* Schnabl), Ent. Tidskr., 41: 28.

1926. *Limnophora tornensis*, Ringdahl, Ent. Tidskr., 46: 102.

♂. Eyes separated on frons by a space about equal to that between posterior ocelli. Frontal and facial orbits very silvery, the latter rather narrower than 3rd antennal joint, but jowls quite as deep as that joint is long. Proboscis slender, theca thinly dusted greyish.

Thorax grey with very narrow median darker stripe, but all darker when viewed from behind. Only three postsutural dorso-centrals, and fine, practically biserial (at least before suture), acrostichals.

Abdominal markings very indistinct except when viewed from behind and then large, quadrate, narrowly separated on middle line, and not sharply contrasted with the rather dark grey ground-colour.

Middle femora with a row of 6–7 long strong postero-ventral bristles extending to beyond middle. Middle tibiae with or without a bristle in front, 1–2 behind, but none beneath.

Hind femora with distinct but not very long (little, if any, longer than femur is thick) postero-ventral bristles on basal half. Hind tibiae with one antero-dorsal and two antero-ventral bristles. Wings brownish at base. Halteres yellow.

Length 3.5-4 mm.

EAST GREENLAND: Hekla Havn, 22.7.92 (*Deichmann*), 1 ♂. Placed under the name *L. triangulifera* in Danish collection.

I have been able to compare this Greenland specimen with a cotype of *tornensis* given me by Ringdahl and have little doubt of their specific identity, in spite of some apparent differences in the shape of the side lamellae of male genitalia. The asymmetrical last abdominal sternite (fig. 20) and anal lamella (fig. 20a¹) of genitalia in the Greenland specimen is due to some accidental malformation of the hypopygium, and this malformation has evidently extended to the side lamellae and caused some slight difference in shape from those of the typical specimens.

21. *L. (Spilogona) trigonifera*, Zett., ♂. Plates XV and XXI.

1840. *Anthomyza trigonifera*, Zetterstedt, Ins. Lapp. p. 669; 1845, Dipt. Scand., 4: 1458.

♂. Large species with frons as wide as facial orbits, which are rather wider than 3rd antennal joint; this joint short, not much longer than 2nd. Arista long, microscopically pubescent. Pointed tip of ocellar triangle shining. Epistoma not all at projecting. Proboscis shining but lightly dusted greyish beneath about middle.

Thorax greyish in front and at sides of disc but more brownish-grey without distinct stripes on centre, and all darker when viewed from behind. Four postsutural dorso-centrals. Lower posterior sternopleural very indistinct. Scutellar setulae not extending down on to sides towards tip.

Abdomen elongate-ovate and dorso-ventrally somewhat flattened. The grey sides have blackish reflections when seen from above, which make the dark markings then appear much more extensive; seen from behind, the first tergite largely dark with a more or less distinct greyish stripe down centre; second tergite with broad quadrate dark patches *very* narrowly separated on middle line, occupying whole length of tergite, wider on hind margin than in front, and with indications of an excision on outer side soon after base; third tergite with similar much smaller patches. First sternite bare. Hypopygium rather shining blackish.

Middle femora with practically complete row of postero-ventral bristles much longer on basal half than at tip, and antero-ventrally with some finer bristly hairs on at least basal half, rather more than half length of postero-ventral ones; hind femora with a practically complete antero-ventral row of bristles and numerous bristly hairs beneath about base, very long postero-ventrally on basal half or more; front tibiae without bristle behind; middle tibiae with no bristle in front, but two behind and one postero-ventral; hind tibiae with 2-3 antero-ventral, 3-4 antero-dorsal and 1-2 postero-dorsal bristles.

Wings faintly yellowish brown, costal ciliation short, outer cross-vein somewhat sinuate. Squamae large, pale yellowish. Halteres yellow.

Length about 6 mm.

WEST GREENLAND: Auleitsivik (Nordskj. Exp. 1883), 2 ♂. "Grönland, Mus. Staeg." 1 ♂, and Westermann's ♂ labelled "*A. trigonifera*, Zetter. Greenland. Vahl."

The single female associated with these males could not be *trigonifera* because it has a dusted greyish proboscis, no postero-ventral bristle to middle tibiae, and some tiny hairs on first abdominal sternite. It is a female of *opaca*, Schnbl. (*freyi*, Ringd.).

22. *L. (Spilogona)*, sp. ♀.

One female, Hekla Havn, 30.7.92 (*Deičmann*).

A somewhat damaged and discoloured specimen having epistoma slightly produced, about as in *sanctipauli* (similar to figure of *pearyi* given by Malloch) is distinct from any other Greenland specimen seen by me in having longer only biserial (at least for presutural) acrostichal bristly hairs; the middle femora with 3-4 postero-ventral bristles about base, middle tibiae two postero-dorsal bristles only, hind femora without postero-ventral bristles, and yellow halteres.

Length rather more than 4 mm.

BRITISH SPECIES.

Since the publication of my revision of the British species in 1921 (*Ent. Mon. Mag.* (3), 7) two additional species have been discovered and are dealt with in the following pages.

23. *Pseudolimnophora nigripes*, Dsv. Plates XVII and XXIV.

In the figure of the genitalia of this species the profile of the superior forceps is omitted.

24. *Pseudolimnophora triangula*, Fln. Plates XVII and XXIV.

25. *Gymnodia humilis*, Zett. Plates XVII and XXIV.

The genitalia of this species show considerable resemblance to those of *Pseudolimnophora*.

26. *L. (Spilogona) aërea*, Fln. Plates XVII and XXV.

27. *L. (Spilogona) baltica*, Ringd. Plates XVII and XXVII.

I can record two additional males of this species from the collection of the late Mr. A. E. J. Carter taken by the late Dr. J. Waterston near Edinburgh on 15th July, 1904.

28. *L. (Spilogona) biseriata*, Stein. Plates XVII and XXV.

29. *L. (Spilogona) brunneisquama*, Zett. Plates XVI and XXIV.

30. *L. (Spilogona) compuncta*, Wied. Plates XVII and XXIV.

31. *L. (Spilogona) contractifrons*, Zett. Plates XVII and XXII.

No figure of the superior forceps (or anal lamella) is given because there is no difference from that of *arctica* (fig. 5a).

32. *L. (Spilogona) curata*, Collin. Plates XVII and XXVI.

This has been sunk as a synonym of *L. kuntzei*, Schnabl (1911) by Karl. If this be correct, our British form is a darker insect than the continental one described by Stein as having the thorax "ziemlich hell aschgrau mit blaulichem Anflug"; while Schnabl's figure of the male genitalia, especially of the "obere Zangen," is very misleading.

Circumstantial evidence is strongly in favour of *curata* being also a synonym of *meadei* Schnabl (1915), a species described from specimens sent to Schnabl by Meade under the name *trianguligera*, Zett. I have examined two males of this so-called *trianguligera* from Meade's collection taken at "Loch Katrine, 6.8.75," and they are undoubtedly my *L. curata*. In each case the position of the pin makes it difficult to see the postsutural dorso-central bristles, but four there undoubtedly are, in spite of Meade's statement that there are only three, a mistake which Schnabl repeats.

33. **L. (*Spilogona*) *denigrata*, Mg.** Plates XVIII and XXV.

34. **L. (*Spilogona*) *griseola*, sp. n., ♂.** Plates XVIII and XXVI.

Closely resembling *contractifrons*, with which species it may easily be confused, having the same three pairs of postsutural dorso-centrals, similar leg chaetotaxy and abdominal markings but abdomen more dorso-ventrally flattened. It is, however, altogether of a rather lighter grey colour, there being particularly far less contrast between the colour of disc of thorax and of notopleural depression; silvery-grey frontal orbits rather wider, frontal bristles shorter, apical bristles to tibiae (other than usual preapical ones) not quite so much developed. Male genitalia very different especially in shape of superior forceps ("obere Zangen" of Schnabl), while the last sternite which is always visible also differs in shape.

Length nearly 5 mm.

This is another northern species of which I possess four males from Perthshire, one taken at Rannoch by Mr. Verrall on June 20th, 1870, and three at Comrie by Mr. A. E. J. Carter on July 9th and 10th, 1907.

The other British species of *Spilogona* with three postsutural dorso-centrals are all darker:—*baltica* has narrow male frons and larger abdominal dark markings; *surda* has wider male frons with narrower orbits and consequently wider black frontalia; *litorea* and *denigrata* (which latter occasionally has only three postsutural dorso-centrals) have subplumose arista and hind femora short-haired postero-ventrally.

35. **L. (*Spilogona*) *insularis*, Collin.** Plates XVIII and XXVI.

36. **L. (*Spilogona*) *litorea*, Flin.** Plates XVI and XXVI.

37. **L. (*Spilogona*) *marina*, Collin.** Plates XVI and XXVII.

It is evident from the examination of a specimen in Meade's collection labelled "*sororcula*, Zett." and "Mr. Billups" that Meade's record of *sororcula* as British was based upon a specimen of *marina*.

38. **L. (*Spilogona*) *mundula*, Collin.** Plates XVIII and XXVII.

In the figure of aedeagus in profile (38c) the tip of penis is shown above the posterior appendage instead of in the usual position between the two appendages.

39. **L. (*Spilogona*) *signata*, Stein.** Plates XVIII and XXVII.

This name has been sunk by Ringdahl as a synonym of *veterrima*, Zett. When describing *signata*, Stein obviously had two distinct species before him, one with a narrower frons in male in which the silvery orbits practically touch, and another with the orbits separated by a stripe somewhat wider than an orbit. These latter were undoubtedly *veterrima*, of which Stein possessed only two males. Of his more common species with the narrower frons to which the name of

signata should be restricted I have seen two British specimens, taken by Mr. H. Britten of the Manchester Museum at Milnthorpe, Westmorland, on June 23rd, 1929, and a male in Kowarz's collection from "Franzbad." The two species are much alike in general features, but *signata* is more extensively grey, the broad dark postsutural stripe begins more abruptly at suture with a very narrow presutural continuation along line of acrostichals only, and the end half of scutellum is grey; postocular bristles shorter, general pubescence on thorax shorter and less numerous, bristles on legs shorter, especially on hind tibiae. The male genitalia (fig. 39) are markedly different from those of *veterrima* (fig. 43).

40. **L. (*Spilogona*) *solitaria***, Collin. Plates XVII and XXV.

41. **L. (*Spilogona*) *surda***, Zett. Plates XVII and XXVI.

42. **L. (*Spilogona*) *vana***, Zett. Plates XVIII and XXV.

43. **L. (*Spilogona*) *veterrima***, Zett. Plates XVII and XXVII.

SWEDISH SPECIES.

44. **L. (*Spilogona*) *carbonella***, Zett. Plates XVIII and XXII.

In fig. 44*b* the profile of superior forceps is not shown.

45. **L. (*Spilogona*) *depressiuscula***, Zett. Plates XVIII and XXIII.

In fig. 45*c* the penis is shown out of its normal position as in *mundula*.

46. **L. (*Spilogona*) *dorsata***, Zett. Plates XVIII and XXIII.

47. **L. (*Spilogona*) *triangulifera***, Zett. Plates XVIII and XIX.

Variation in the shape of upper forceps is shown in figs. 47*a* and 47*a*¹, both Swedish specimens. Fig. 47*a*¹ is from a specimen captured at Vallistañ, the other figures from one captured at Abisko.

I have to thank Mr. Ringdahl for the specimens of the above four species.

Among the *Limnophora* females in the material from the Danish collection there was one specimen of *Pogonomyia groenlandica* and two specimens of what I believe to be the *Aricia frenata* of Holmgren; if so, the practically bare arista, the presence of distinct acrostichal bristles with small hairs between them as well as general shape and appearance place this species in the genus *Lophosceles*, Ringd.

With regard to the genus *Pogonomyia* it should be noted that Malloch in 1919 (*Canad. Arctic Exped. Diptera*, p. 67*c*) founded a genus *Pogonomyoides* on a female from Bernard Harbour, North West Territories, to which he gave the name of *atrata* and distinguished it from *Pogonomyia* by its weak or absent prealar bristle, hairy pteropleura, absence of ventral bristle at apex of front tibiae and absence of any conspicuous bristles at apices of fore tarsal joints ventrally. In 1920 (*Trans. Amer. Ent. Soc.*, 46: 161) he recorded a pair from West Greenland and described the male as having "the fore coxae produced in the form of a large stout rounded protuberance at apex anteriorly," the middle femora apparently similar to that of *groenlandica*, Lundb., and hind tibiae "slightly produced at apex on ventral side." I have a strong suspicion that

atrata, Mall., will be found to be a synonym of *Pogonomyia segnis*, Holmgr., and Lundbeck writes to me that he considers such a synonymy very probable.

In 1921 (*Proc. Calif. Acad. Sci.*, 11: 178-182) Malloch erected yet another genus *Eupogonomyia* with *pribolofensis*, Mall., as type, and included *groenlandica*, Lundb. This genus is said to differ from *Pogonomyia* in having prealar bristle absent or minute, hind tibiae in male with fine setulose hairs instead of strong bristles on postero-dorsal surface and its apex produced on ventral side; fore tarsi short and stout with two or more bristles at apex above on fourth segment; hind tarsus with two outstanding short bristles near base on ventral surface. Pteropleurae bare.

I am not prepared to give an opinion on the status of these proposed genera.

The specimen of *P. groenlandica* mentioned on the previous page was included in the Danish collection among the series of *Limnophora hyperborea* and is from East Greenland (Hekla Havn, 15.vii.92), a locality from which it has not previously been recorded.

The *Lophosceles frenatus*, Holmgr., were mixed with the series of *Limnophora arctica* and are from West Greenland (Orpiksuit, 16.vii.90). They closely resemble British females of *cristatus*, Zett. (*pulcher*, Meade), but are rather larger with slightly wider facial orbits or cheeks, and have two short outstanding prealar bristles instead of the one small less outstanding one of *cristatus*.

I have also examined the types of the following species described by Holmgren from Greenland:—

Aricia tristicula, Holmgr., 1 ♂. Correctly sunk as a synonym of *Paregle radicum*. The thorax is greyer in front than is usual in European specimens and there is no pair of prescutellar acrostichals, but the male genitalia agree in all respects.

Aricia icterica, Holmgr., 1 ♀. This I feel sure will prove, when the male is examined, to be more correctly placed in the genus *Pegomyia*; the costa bears hairs beneath below the double row of tiny bristles and the hind tibiae have only two pairs of bristles above. The head in profile is rather square with wide cheeks and jowls and there are no cruciate bristles on frontal stripe.

Aricia moesta, Holmgr., 1 ♂ 1 ♀. As already stated by Stein this is at most only a variety of *octoguttata*, Zett. The male genitalia agree with those of British specimens of that species. It is undoubtedly closely related to *Lasiomma roederi*, Kow.

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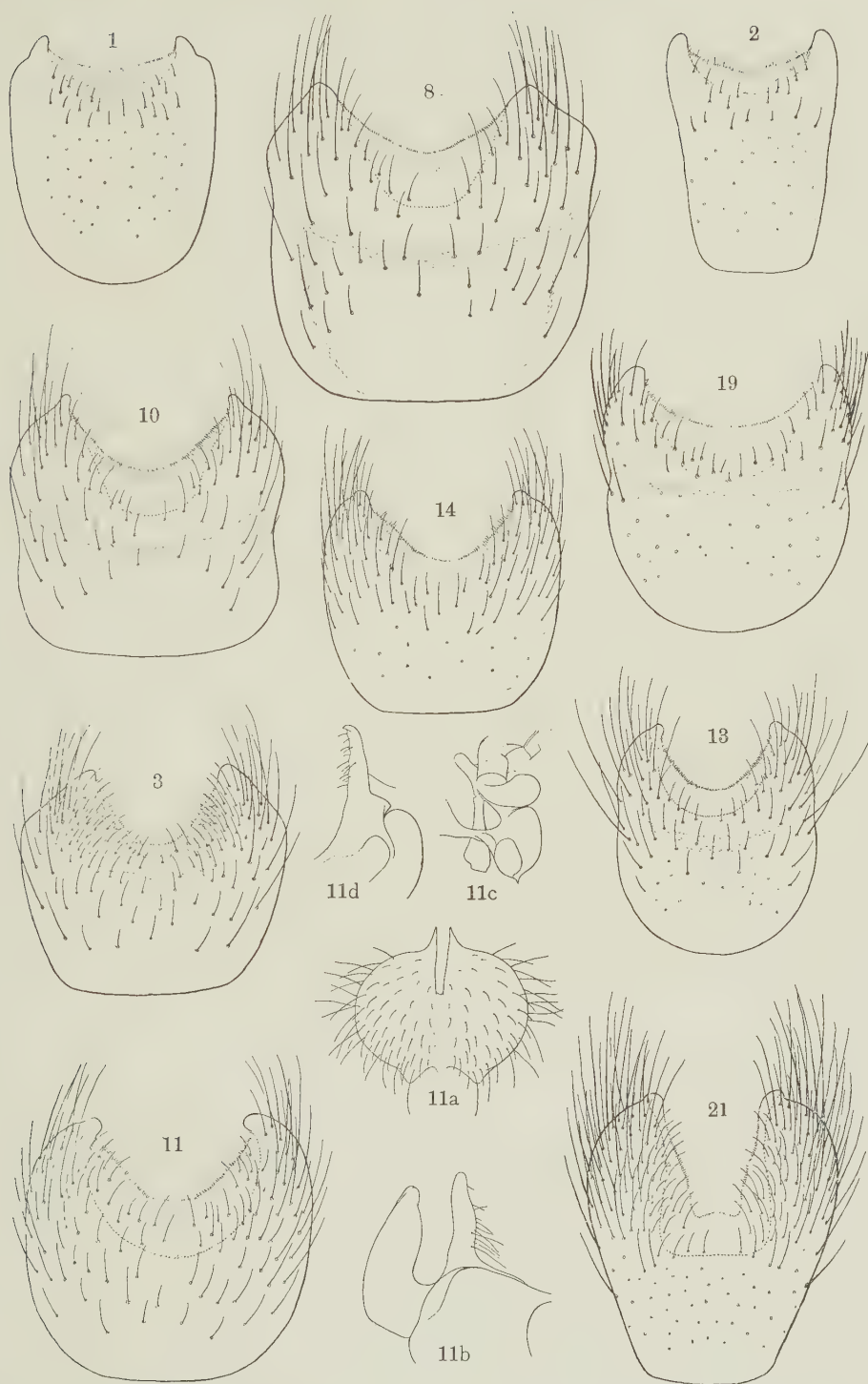
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* B. indicates recorded from Britain, S. Scandinavia, G. Greenland.

EXPLANATION OF PLATES XV-XXVII.

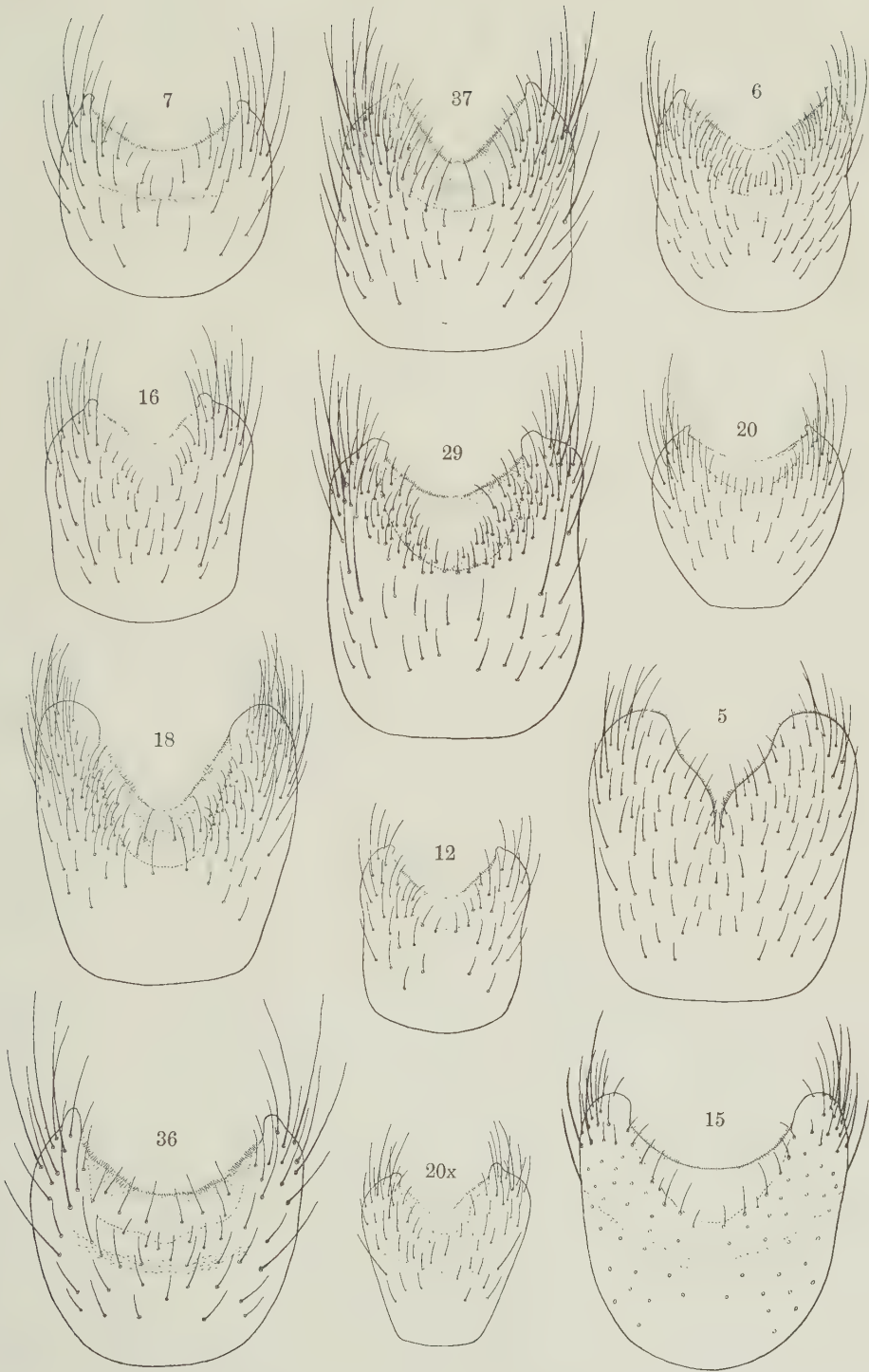
Male genitalia of species of *Limnophora* sens. lat.

The figures of different parts of the genitalia of a species all bear the same number as is prefixed to the specific name in the description, while similar parts in different species are indicated by the same letter throughout, "a" being a view of the fused anal lamellae or upper forceps, "b" a profile of hypopygium (usually without the fulcrum and aedeagus) showing in most cases the upper forceps and side lamellae (lower forceps), "c" a profile of the fulcrum and aedeagus, "d" a view of the side lamellae from behind, *i.e.* from the left of the profile view.



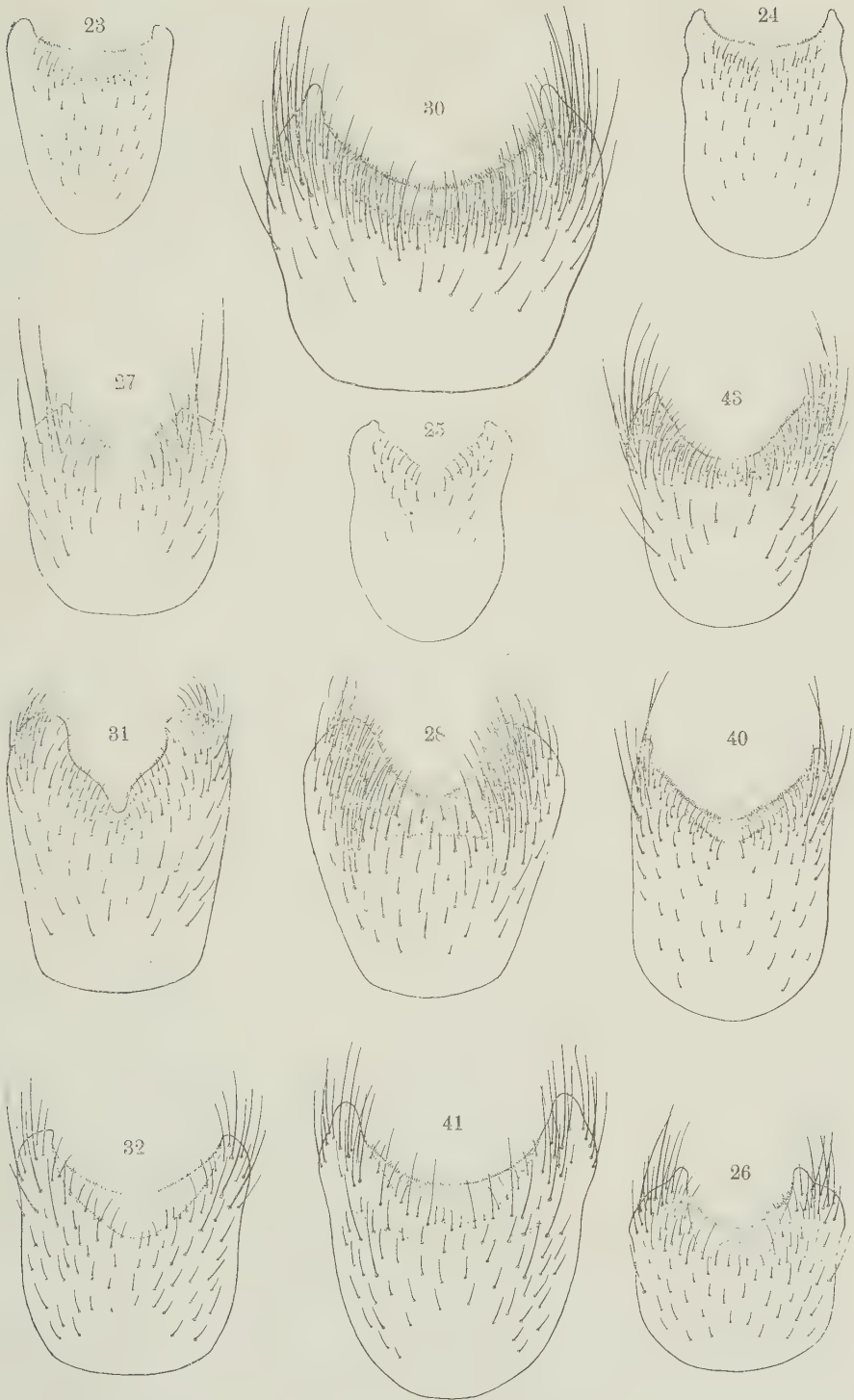
Male genitalia of *LIMNOPHORA* sens lat.

- 1 *rotundata* 8 *macropyga* 2 *sinuata* 10 *hyperborea* 14 *micans*
 19 *semiglobosa* 3 *almquisti* (co-type of *rostrata*) 13 *megastoma*
 11 *latilamina* 21 *trigonifera*



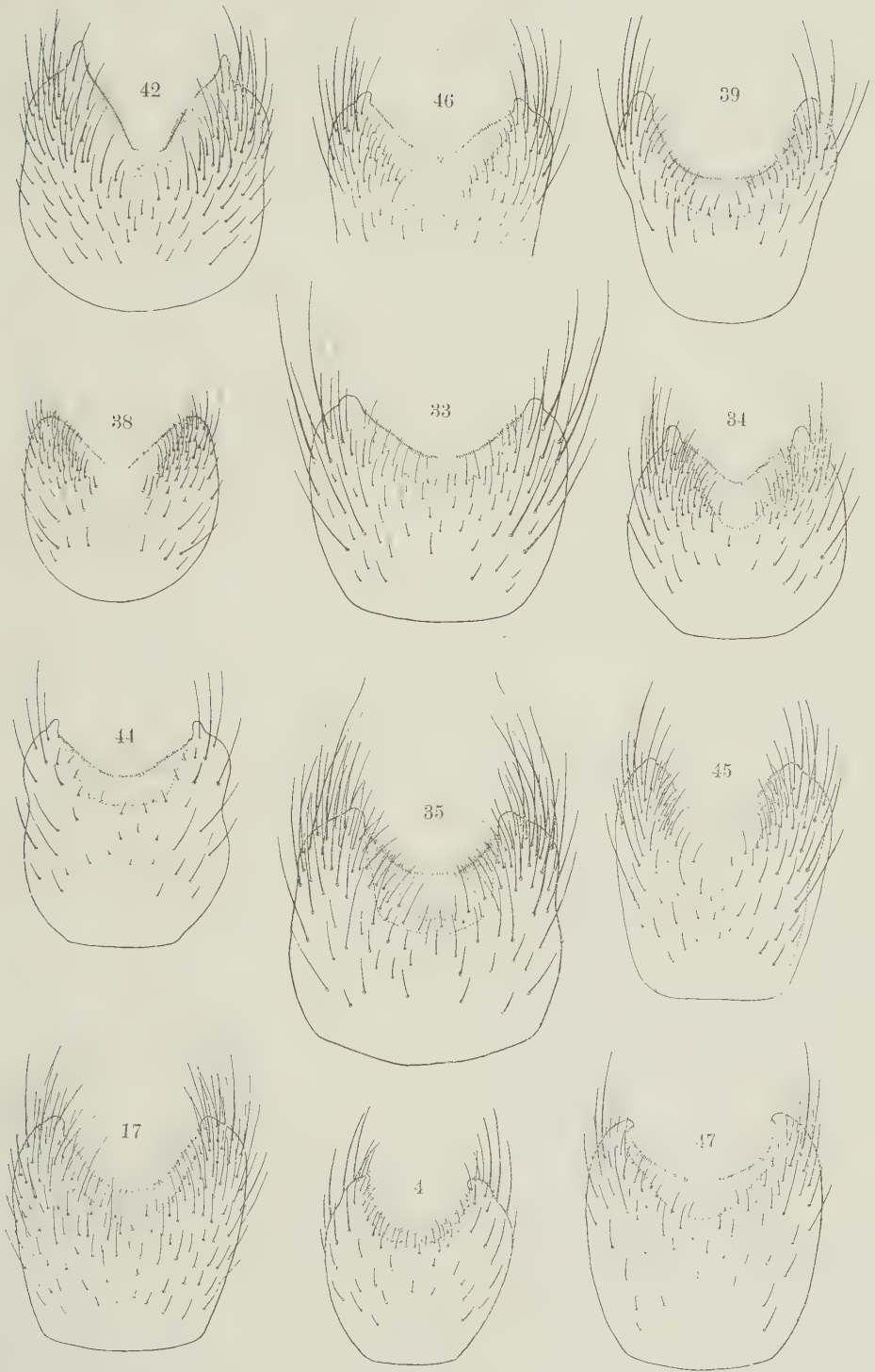
Male genitalia of *LIMNOPHORA* sens lat.

7 *denudata* 37 *marina* 6 *deflorata* 16 *obsoleta* (Greenland)
 20 *tornensis* (co-type) 29 *brunneisquama* 18 *sanctipauli* 12 *malaisei*
 5 *arctica* 36 *litorea* 20x *tornensis* (Greenland) 15 *monacantha*



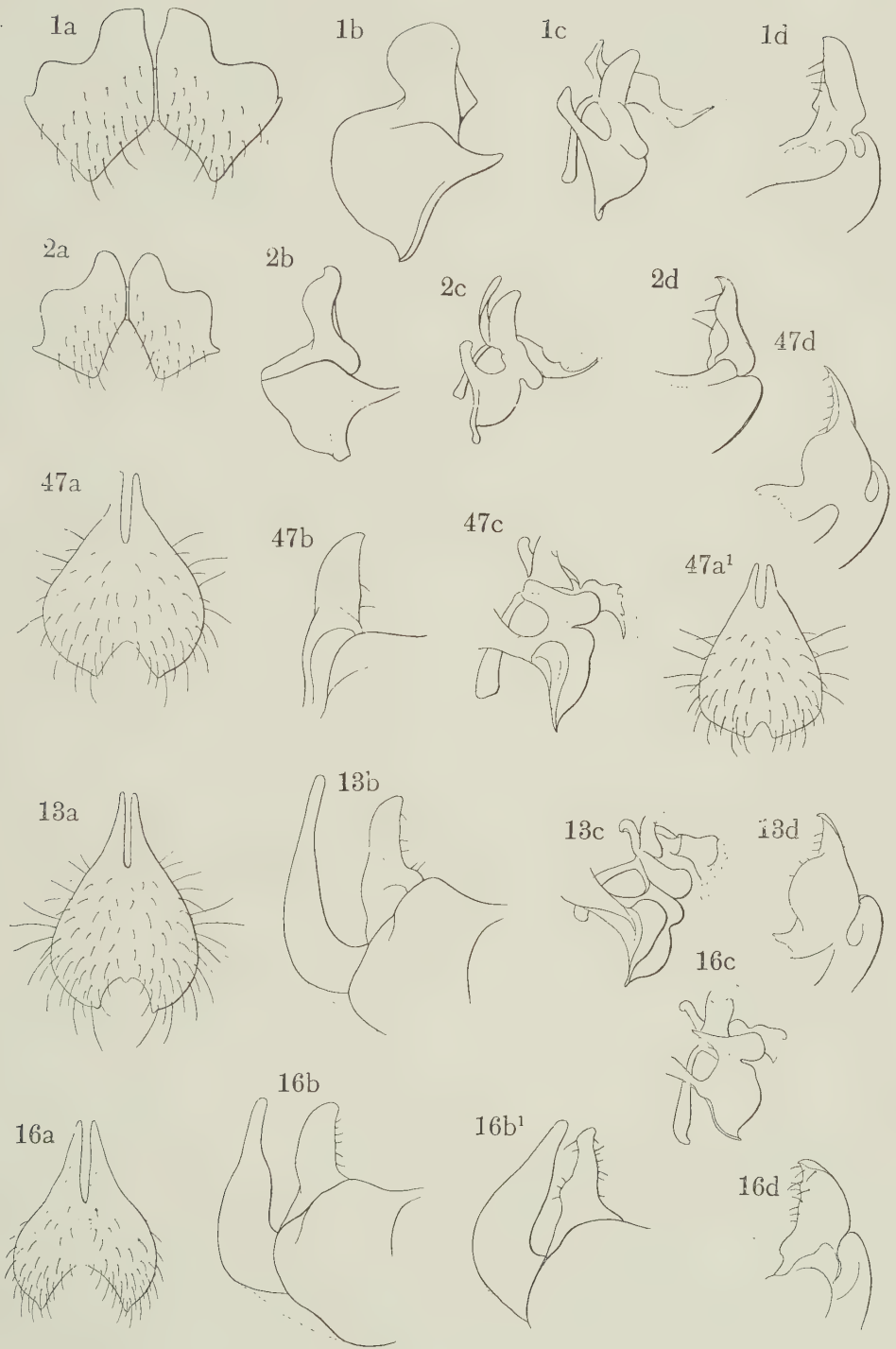
Male genitalia of *LIMNOPHORA* sens lat.

- | | | | | |
|---------------------|--------------------------|---------------------|---------------------|-------------------|
| 23 <i>nigripes</i> | 30 <i>compuncta</i> | 24 <i>triangula</i> | 27 <i>baltica</i> | 25 <i>humilis</i> |
| 43 <i>veterrima</i> | 31 <i>contractifrons</i> | 28 <i>biseriata</i> | 40 <i>solitaria</i> | |
| | 32 <i>curata</i> | 41 <i>surda</i> | 26 <i>aerea</i> | |



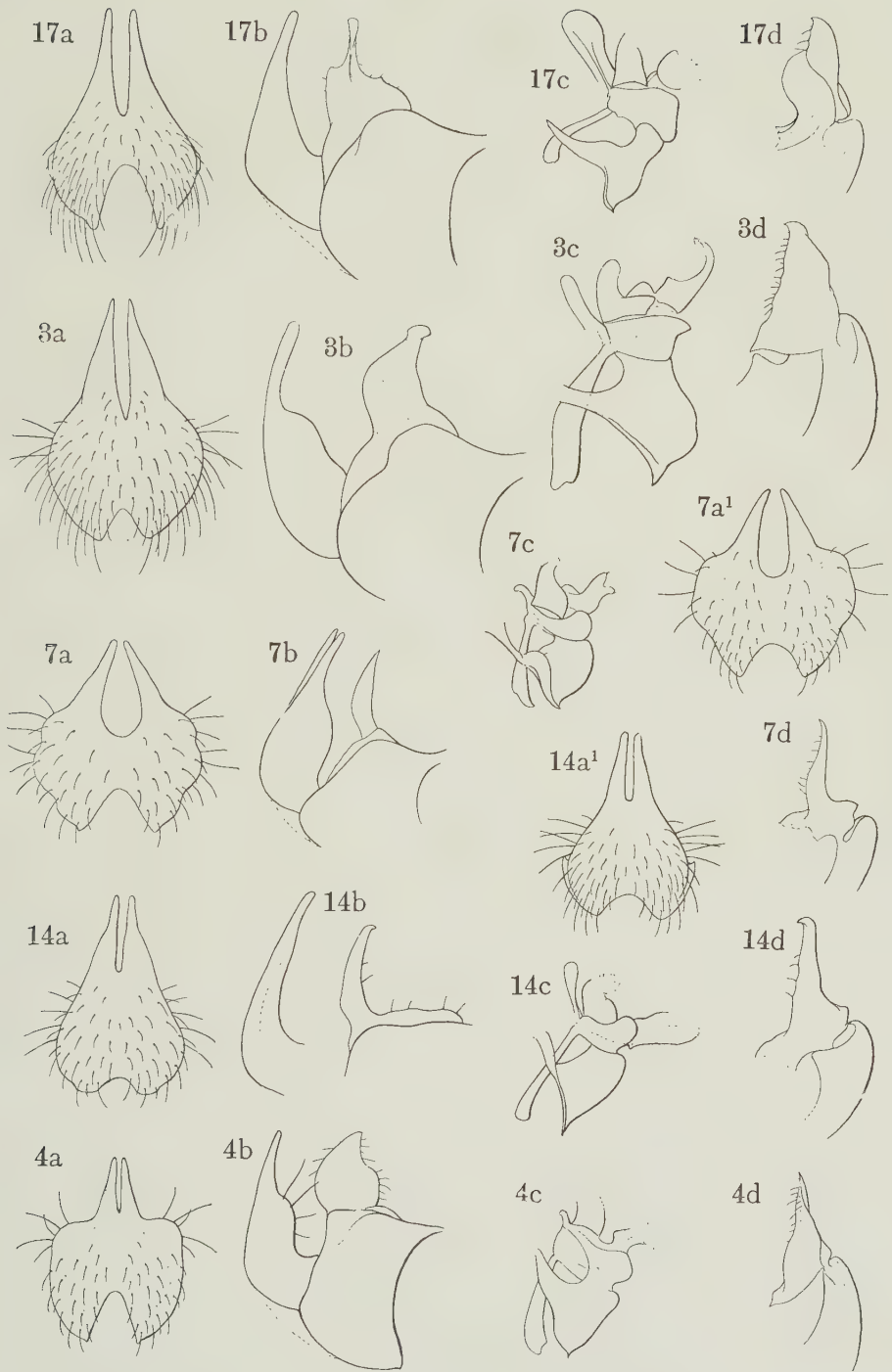
Male genitalia of *LIMNOPHORA* sens lat.

- | | | | | |
|--------------------|----------------------|-------------------------|--------------------------|---------------------|
| 42 <i>vana</i> | 46 <i>dorsata</i> | 39 <i>signata</i> | 38 <i>mundula</i> | 33 <i>denigrata</i> |
| 34 <i>griseola</i> | 44 <i>carbonella</i> | 35 <i>insularis</i> | 45 <i>depressiuscula</i> | |
| 17 <i>opaca</i> | 4 <i>alpica</i> | 47 <i>triangulifera</i> | | |



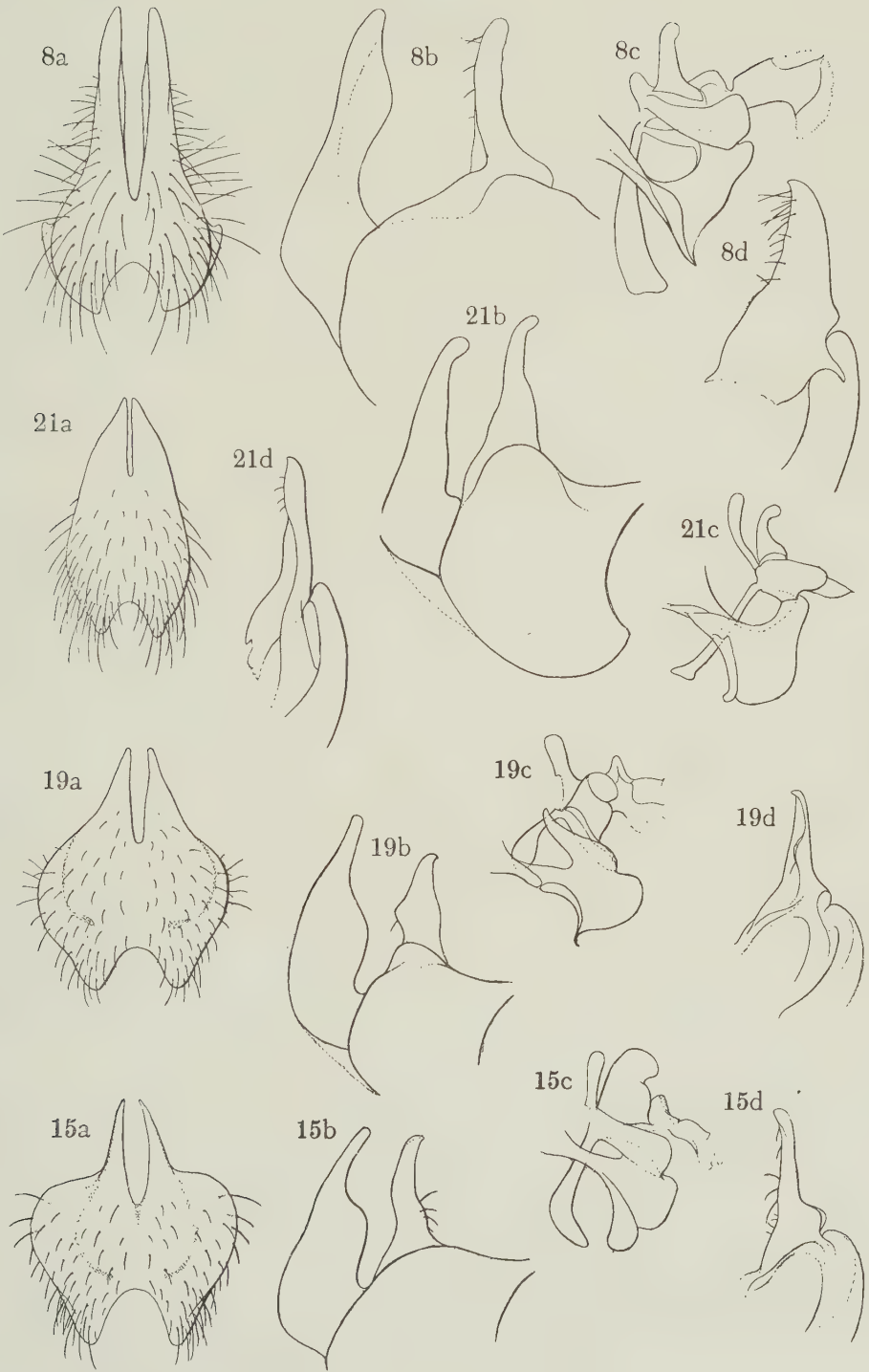
Male genitalia of *LIMNOPHORA* sens lat.

1 *rotundata* 2 *sinuata* 47 *triangulifera* 13 *megastoma*
 16 *obsoleta* (Greenland) but 16b (America)



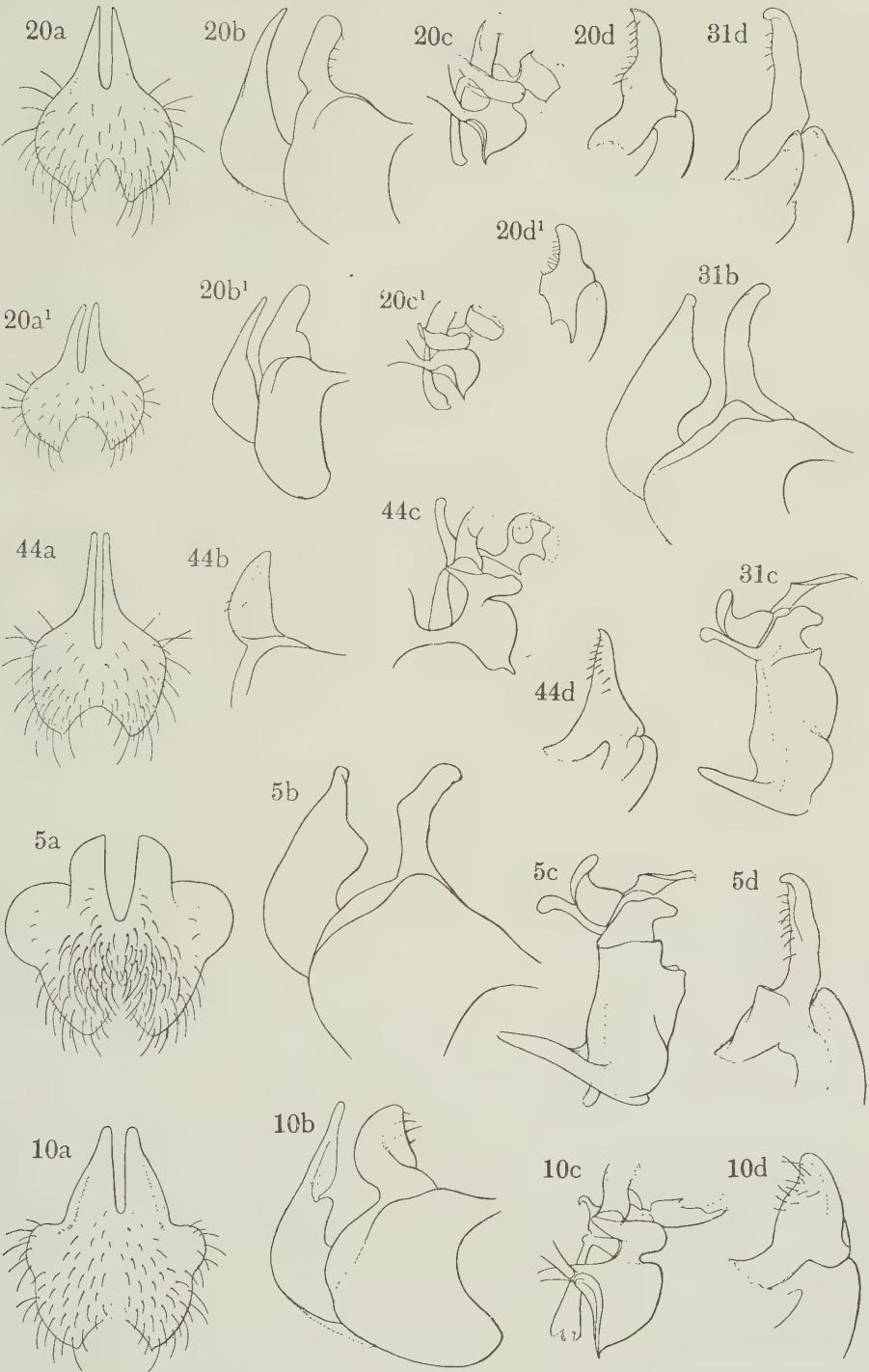
Male genitalia of *LIMNOPHORA* sens lat.

17 *opaca* 3 *almquisti* (co-type of *rostrata*) 7 *denudata* (Greenland)
 7a¹ (Type) 14 *micans* (Greenland) 14a¹ (Type) 4 *alpica*



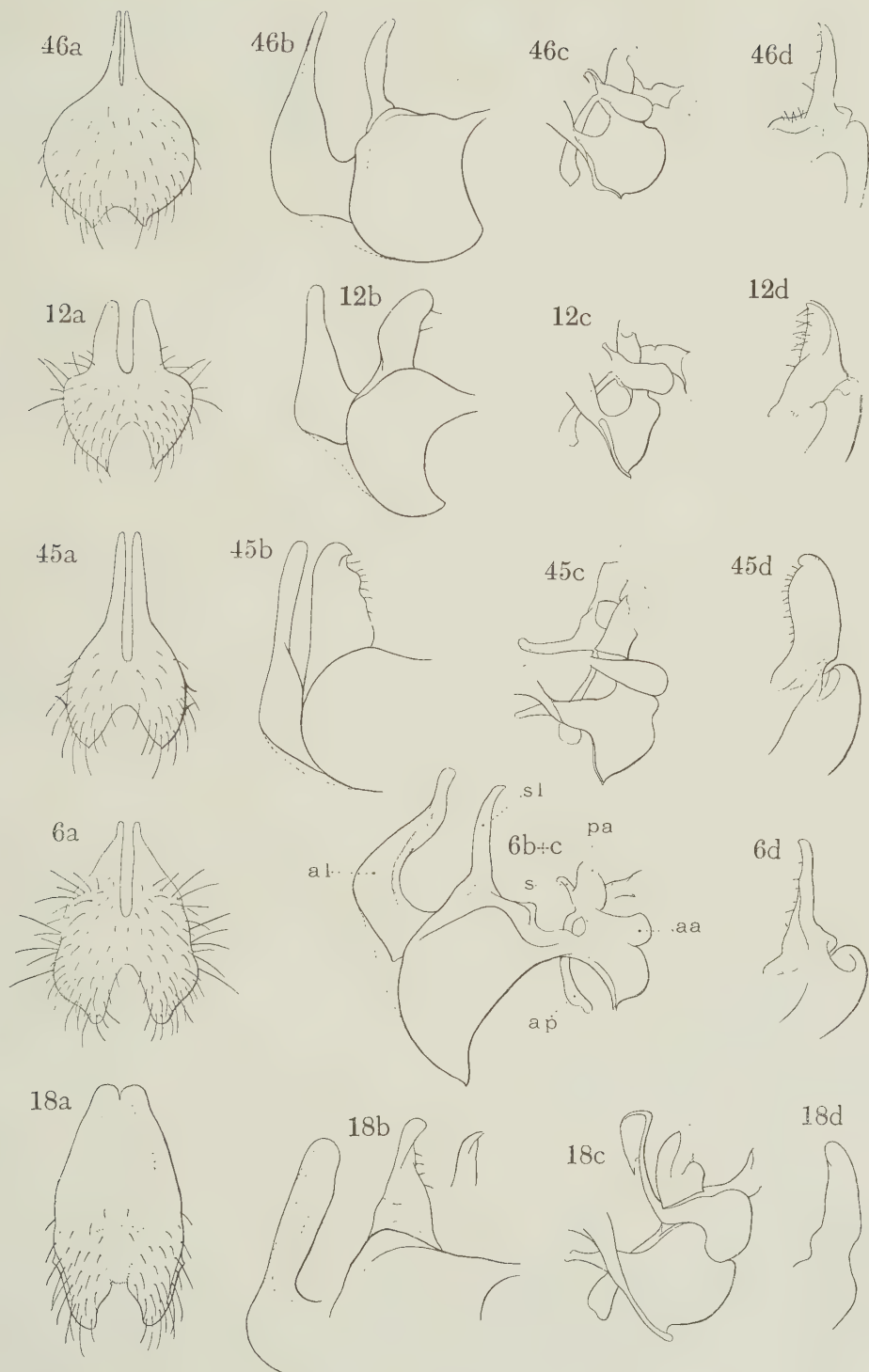
Male genitalia of *LIMNOPHORA* sens la'.

8 *macropyga* 21 *trigonifera* 19 *semiglobosa* 15 *monacantha*



Male genitalia of *LIMNOPHORA* sens lat.

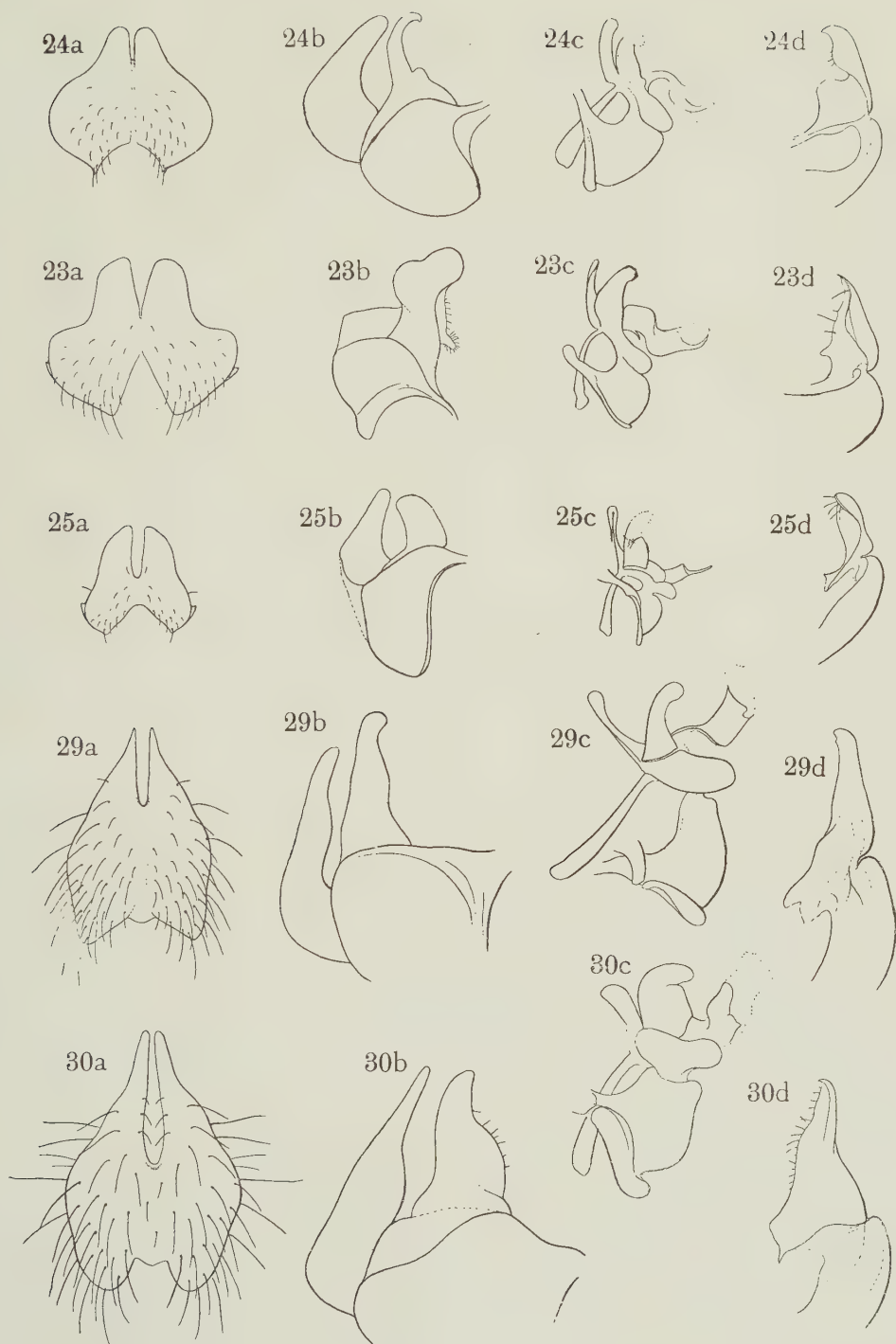
20 *tornensis* (co-type) 20¹ (Greenland) 44 *carbonella* 5 *arctica*
10 *hyperborea* 31 *contractifrons*



Male genitalia of *LIMNOPHORA* sens lat.

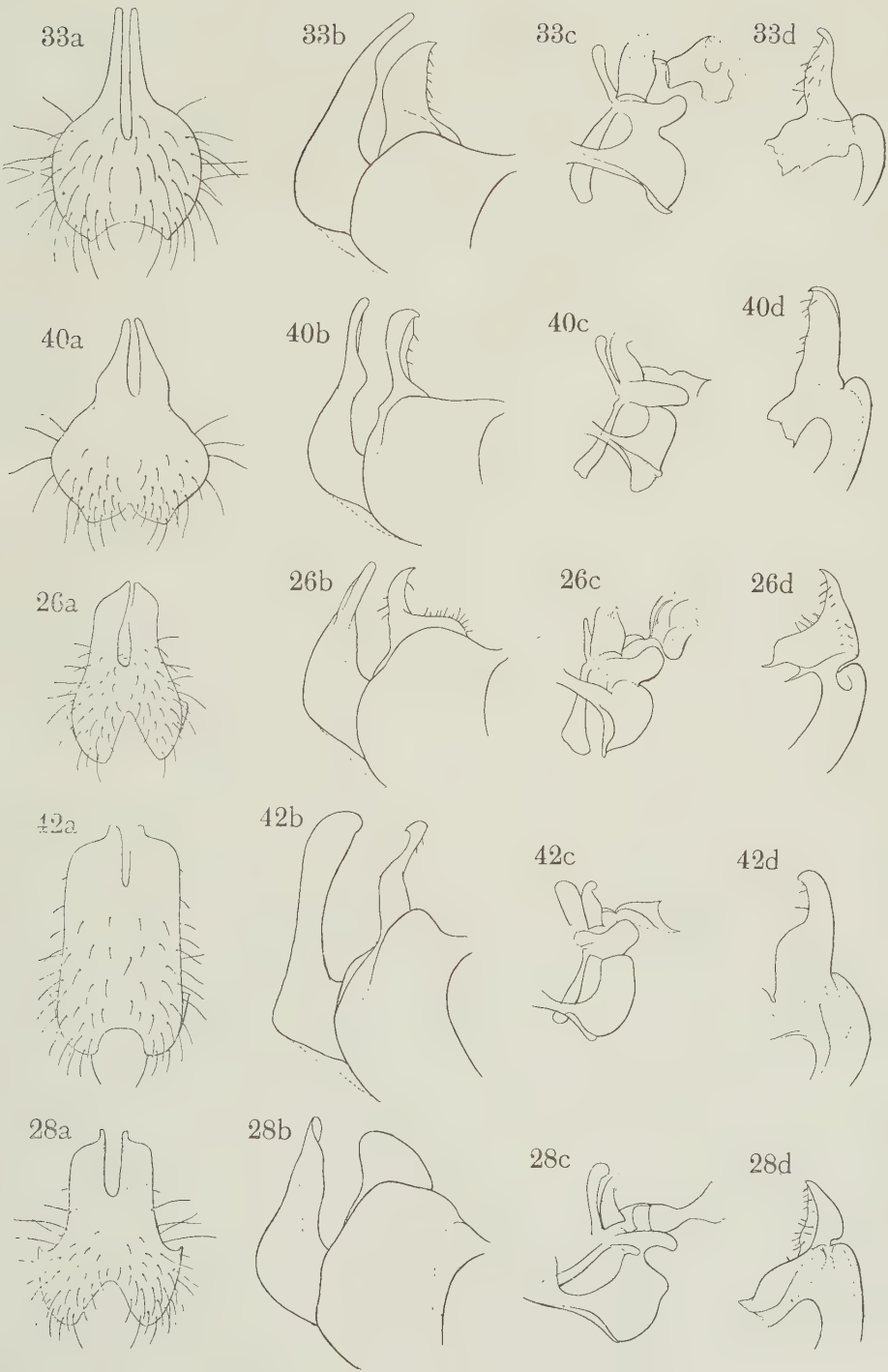
46 *dorsata* 12 *malaisei* 45 *depressiuscula* 6 *deflorata* 18 *sanctipauli*

6b+c aa—anterior appendages, ap—apodeme, al—anal lamellæ,
sl—side lamellæ, s—stylus, pa—posterior appendages



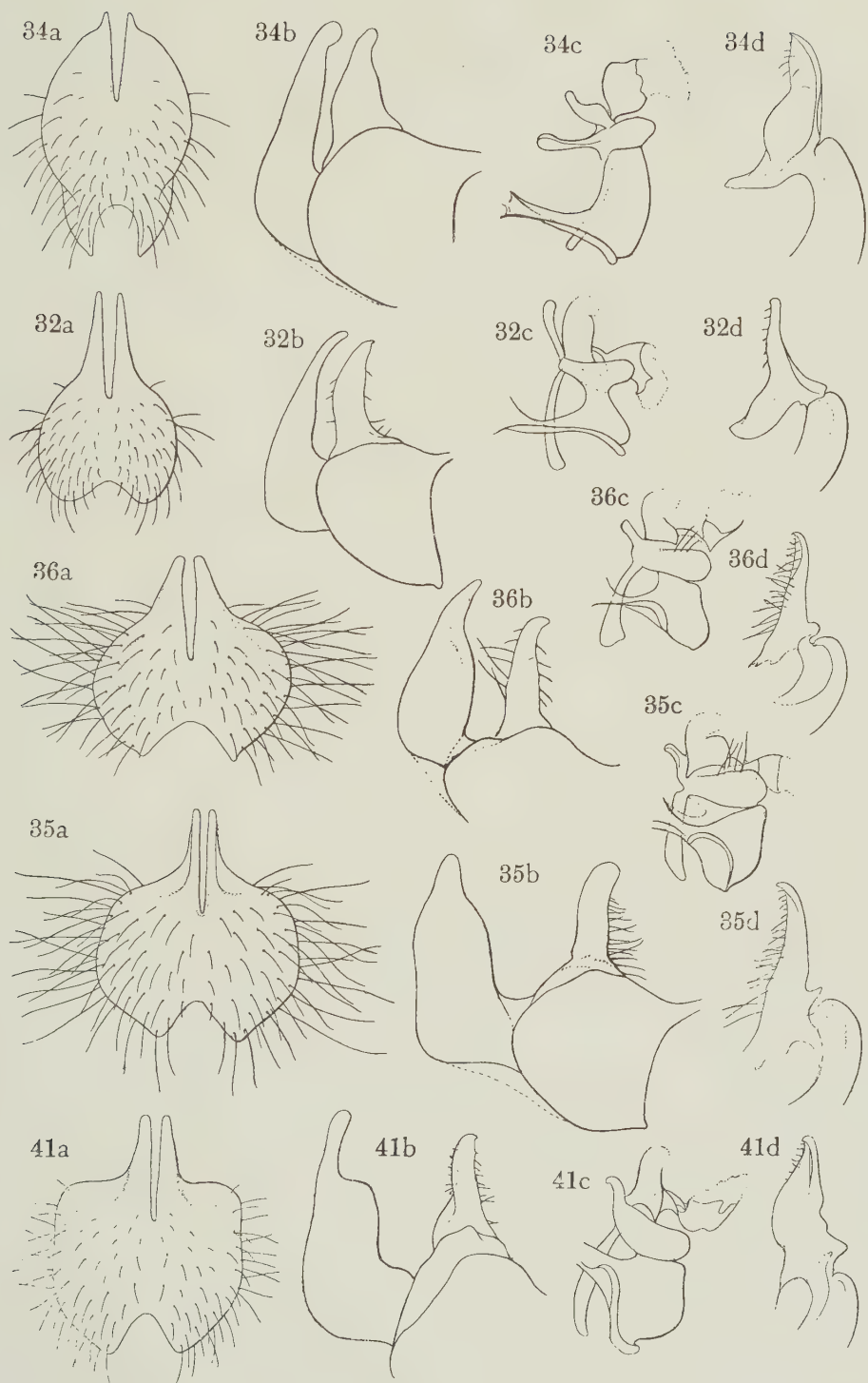
Male genitalia of *LIMNOPHORA* sens lat.

24 *triangula* 23 *nigripes* 25 *humilis* 29 *brunneisquama*
30 *compuncta*



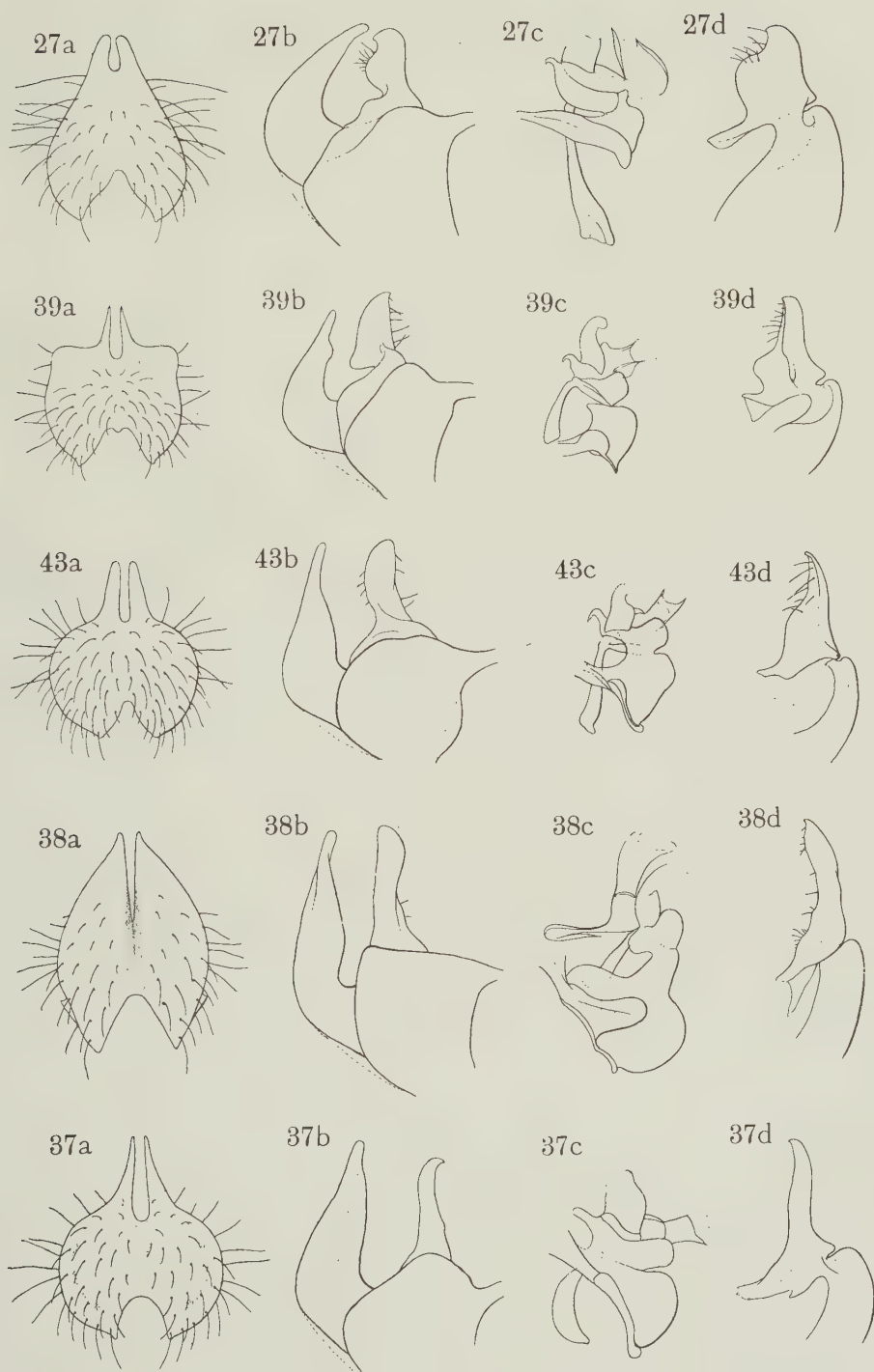
Male genitalia of *LIMNOPHORA* sens lat.

33 *denigrata* 40 *solitaria* 26 *aerea* 42 *vana* 28 *biseriata*



Male genitalia of *LIMNOPHORA* sens lat.

34 *griseola* 32 *curata* 36 *litorea* 35 *insularis* 41 *surda*



Male genitalia of *LIMNOPHORA* sens lat.

27 *baltica* 39 *signata* 43 *veterrima* 38 *mundula* 37 *marina*

PSAMMOCHARIDAE (POMPILIDAE) AND SPHECIDAE

COLLECTED RECORDS OF THEIR DIFFERENT METHODS OF FILLING IN THE STOCKED BURROW

By G. D. HALE CARPENTER, D.M., F.L.S., F.Z.S.

[Read June 4th, 1930.]

SECTION I.

THE fact that Psammocharids and Sphecsids use different methods when filling up their burrows has impressed me ever since I first saw fossors at work on the Riviera in 1899. The habits of these wasps were therefore noted from time to time after I went to Uganda in 1910, and nothing has been seen contrary to my early conclusion, which may be stated as follows.

The loose soil which is thrown into the burrow by the legs, if it is pressed down at all, is pressed down by a Psammocharid with the end of the abdomen, either slowly with deliberate movements or by a series of extremely rapid strokes. A Sphecid, on the other hand, rams the earth down with the front of the head.

It may be at once stated that I do not mean to imply that a Psammocharid invariably uses the abdomen, or a Sphecid the head; only that each uses the appropriate method, if ramming down forms part of the series of movements which it must carry out.

My earliest observations were communicated to the Entomological Society in the *Proceedings* for Nov. 5th, 1913, but no further notes on this interesting point have since been published by the Society, and as I know of no published generalisation on the subject I have here brought together all the evidence that could be obtained within a very limited time. The literature searched began with the Peckhams' famous work, and the references given therein and in a paper by F. X. Williams entitled "Philippine Wasp Studies." The *Zoological Record* was then consulted, and I worked backwards through it as far as time allowed, which brought the work to a stop at the year of publication of Peckhams' work, 1898. The records consulted were all those in English or French which were available in the libraries of the Entomological Society, Imperial Institute of Entomology, Natural History Museum and Zoological Society. Fabre's *Souvenirs Entomologiques* were of course also consulted, but with little result.

This search yielded records of 28 observations on 25 species of PSAMMOCHARIDAE by 9 authors, and of 46 observations on 31 species of SPHECIDAE by 21 authors. Also 11 observations on LARRIDAE of considerable interest have been quoted, with one on a Scoliid and 2 on Bembecids; all bearing on the point under discussion. I do not claim that this list is complete: it is highly probable that the time factor has resulted in my overlooking some valuable records, and also I have not been able to deal with any in German. These observations are all in accord with the generalisation stated above, which may thus, I think, be fairly considered to be established.

It is interesting to note that several prominent entomologists, who were
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asked if they could contribute any notes of their own experiences, expressed considerable doubt whether the difference I had noted would be found to hold good in general.

Thus, "I believe myself that whereas the Pompilids which burrow nearly always use their abdomen there would be many exceptions to the rule that Sphegids *don't* use their abdomen. I doubt if the difference is very deep-seated." Another spoke similarly. On the other hand Mr. O. H. Latter wrote, "Certainly I have never seen a Pompilid use its head as a rammer, but I have seen this done by several Sphegids, especially species of *Ammophila*."

It is obvious, when literature is searched, that comparatively little attention is paid to the exact manner in which the burrow is filled: this is regrettable, for such a manoeuvre is surely as much an expression of the individuality of the fossor as any other. The paucity of records is partly to be explained by the fact that an observer is often anxious to establish the identity of the species and its prey, and as soon as the latter has been bestowed in the chamber the wasp is captured for record. One often has to choose between certain identification of a fossor, with an incomplete record of its habits, and a complete record, with risk of the worker suddenly eluding capture at the end. Many observations in publications that have been consulted merely state that the burrow was filled up; the observers were more interested in the procedure of finding, stinging, and transporting the prey, and the subsequent oviposition, than in the closing act of the drama. It is hoped that this paper may direct attention to this point and call forth a plentiful crop of further records.

A study of the modern classification of the Hymenoptera, such as that adopted by Imms in his *General Text-book of Entomology*, shows that the old title of "Fossors," founded on a physiological rather than a morphological basis, can now no longer be used for a natural group. Although a large proportion of the wasps that excavate burrows in which the stung prey is bestowed is included in one group, the SPHECOIDEA, families SPHECIDAE, LARRIDAE, and BEMBECIDAE, the extremely interesting and equally typical fossorial PSAMMOCHARIDAE (POMPILIDAE) are now included with the true wasps (the old Diplop-tera) in the group VESPOIDEA together with the SCOLIIDAE and VESPIDAE.

Since PSAMMOCHARIDAE and SPHECIDAE are morphologically not very closely allied, it is of some interest to find that a very distinct biological difference can be established. The reason for this, could it be found, would be of interest. Does it lie in the broad front of the Sphecid head which would seem to be a much better ram than the somewhat smaller, more rounded, head of the other family, which prefers to employ the abdomen? Or is the position of the antennae, eyes, etc., on the Psammocharid head such that they would be damaged in the process of ramming?

SECTION II.

A. RECORDS OF PSAMMOCHARIDAE.

(N.B.—Italics are mine.)

GROUP I.

1. *Aporus fasciatus*, Smith.

She began to fill the hole that she had made, kicking in the earth until the entrance was hidden. . . . *Loose earth was kicked under the body by the first legs.*

2. *Psammochares irpex*, Gerst.

I first saw it running quickly about, obviously searching for something, and soon it came to a spot where it scratched away a little loose sand and laid bare a spider, paralysed, and apparently hidden away until the wasp had found a suitable spot in which to bury it. The wasp then took it up and ran backwards with it for a good many yards . . . until she came to the spot where the burrow had been previously dug, for she put the spider down, took away a lump of sand, and laid bare a very shallow hole into which she put the spider without going down herself, and quickly covered it up with loose sand.

3. *Pompilus rufipes*.

Female filled in burrow by *scratching inside and round entry*: funnel-shaped depression so left was filled up with very small pebbles and bits of dead grass.

GROUP II.

4. *Pompilus interruptus*, Say.

She came out and began to *cut away the earth near the entrance and to push it in*, and then, after a little, to fill the hole with the dirt that had been taken out, which she *pushed down with her legs*.

GROUP III.

5. *Pompilus quinquenotatus*, Say.

In filling up the hole *quinquenotatus* shows a great deal of variation, sometimes coming out of the hole and *sweeping in the dirt with her first legs* and sometimes standing in the tunnel while she *draws the earth in with her mandibles* and then *jams it down with the end of her abdomen*.

6. *Pompilus biguttatus*, Fabr.

The filling is sometimes done from within, the wasp standing in the hole while she *draws the earth in with her mandibles* and *jams it down with her abdomen*; and sometimes from without, the *earth being kicked in* and the surface then smoothed over.

7. *Pompilus scelestus*, Cresson.

She emerged from the opening, and standing on the four posterior legs, with her abdomen hanging down into the hole, *scratched the earth backward with the front legs* and mandibles. As it fell in she *pushed it down with the abdomen*, and as the hole filled she raised herself higher and higher on her legs, still *using the tip of the abdomen* to work the material into place.

8. *Pompilus marginatus*, Say.

The wasp remained inside for fifteen minutes and finally appeared *scratching in sand* and *stepping it down into the nest*. When this was nearly full, she pulled down the dry sand from above the entrance, *biting it loose with her mandibles*.

9. *Pompilus viaticus*, L.

It filled its hole in the following way. It placed itself in the mouth of the burrow with the abdomen pointing down it. Then with its mandibles

and front pair of legs it *scratched earth from the margin of the hole* in front of it and then scratched it backwards into the hole. It then *rammed it down with its tail*.

10. *Pompilus viaticus*, L.

When the egg has been laid the wasp slowly ascends the burrow, throwing down earth with its legs as it goes. On reaching the surface the wasp pulls earth from round about and *presses it down with the tip of its abdomen*.

11. *Pompilus viaticus*, L.

Watched a female filling in shallow burrow. *Tip of abdomen used to ram soil* into burrow and press it firm. To the best of my recollection this is the only occasion on which I have seen the abdomen used in this way. I have watched *P. plumbeus* for hours in various places. . . . I do not remember to have seen this species employing the abdomen as a rammer. I am sure I should have made a note of it if I had. I have a note about *P. rufipes*, showing that this species sometimes does not use the abdomen thus. (See Record 3.) This does not mean to imply that *P. rufipes* does sometimes use the abdomen. I have never seen it do so. What I mean is that if it is known to do so sometimes, my observation shows that it sometimes adopts other methods. I feel sure that if I had seen the abdomen used as a rammer in either of these cases I should have recorded it. Certainly I have never seen a Pompilid use its head as a rammer.

GROUP IV.

12. Species undetermined, black with blue-black wings.

Having deposited an egg she proceeded to fill up the burrow as follows. She remained in the mouth of the burrow, and, with only head and legs outside at first, reached earth from the pile towards her, and then settled it into the hole by curious *shuddering movements of the abdomen*. This contrasted with *P. viaticus* (see 9), which pressed down the earth with slow deliberate thrusts.

13. *Pompilus bretoni*, Guér.

A brief interval sufficed for the egg-laying, and then the wasp proceeded to fill up the hole, which it did in exactly the same manner as obs. 12, *using the abdomen to ram down the earth*: the whole body undergoing such quick movements that the outline was blurred, as when a spider makes itself invisible by shaking the web.

14. *Batozonus fuliginosus*, Klug, var. *sepulchralis*, Sm.

The Pompilid stood in the hole and pulled the loose earth down with her anterior legs. Then she *rammed down the earth with the end of the abdomen*, throwing the whole body into such *quick, shuddering vibrations*, that her outline became blurred, and one heard a succession of quick raps on the ground *reminding one of a pneumatic riveting machine* at work. The whole process was extremely rapid.

15. ? *Salix* sp. Black, with orange antennae.

I watched with great interest to see whether it would use the usual method of filling up its burrow, which it did; throwing its body into *very rapid vibrations*

which, as it *rapped the earth down with the end of the abdomen*, made a distinct noise, *like riveting with a pneumatic hammer*.

16. *Batozonus bioculatus*, Bingham.

She was engaged in filling up the burrow, tamping down the soil vigorously *with the end of her abdomen*. This tamping was done with such a rapid motion that the *wasp was seen to fairly vibrate* in a longitudinal plane. She bit off the top edges of the burrow and sometimes brushed in a little soil with her fore-feet, then tamped again. Tamping was long sustained and constituted by far the principal filling operation, being very effective in making a firm blending core of soil. When the burrow was but little filled the tamping insect was in an approximately vertical position.

17. *Pompilus quadripunctatus*, Fabr.

A *P. quadripunctatus* closed up its nest in which it had just hidden an *Argiope lobata*, Pallas (Escaffarels, 7th Sept.) The burrow had been dug horizontally into the earth, in firm sand at the bottom of a small excavation made several days previously by another insect, probably a *Bembex*. This cavity, 1 cm. in depth, 2 in width and 4 in length, was hidden on the side of the burrow by an arch of sand 1 cm. in length, but a bright sun lit up the interior with its direct rays and enabled me to see as well as possible. The Pompilid had already filled up the burrow it had dug with sand, and the large cavity in question remained to be completed. Before doing this, it pounded for a long time the surface of the sand with which it had rammed the passage so as to strengthen it, doubtless to form an obstacle to certain parasites. The insect stands on its six feet and *strikes the soil with repeated blows with the end of its abdomen*. The blows follow each other with such speed that I cannot distinguish them although I was less than 1 metre's distance from the Pompilid. I perceive all at once the abdomen through the whole extent of its vibrations, directing the taps in little series sometimes to the right, sometimes to the left, or to the centre. *The whole body of the insect vibrates*, and one can hear a sort of rustling, while the abdomen is animated with this rapid vertical coming-and-going movement, *recalling certain mechanical hammers*. From time to time the wasp stops to examine with its antennae the effect produced, pulls away a little sand in the neighbourhood of the cavity, and gives several raking strokes, probably to throw out grains which are too large. It takes a little rest, and begins pounding the soil again.

This strange manoeuvre lasted an hour, after which the Pompilid finished the completion of the cavity with sand thrown from above by its rakings. This last piece of work was carried out quickly: once only the beast pounded the surface of the rejected sand for some instants. Finally the Pompilid scraped the soil, first above the nest, then at some distance, going further and further away, and was apparently about to fly away when I took it.

When it had finished its nest, the wasp, always quick and alert, did not seem fatigued. One can judge from this the energy and vigour of these insects, especially when I add that a series of these tapplings lasts without interruption for a quarter of an hour.*

* I am greatly indebted to Mr. Francis Griffin, Registrar of the Entomological Society, for posting to me the translation he made of a record which I had unaccountably overlooked.

18. *Pompiloides tropicus*, L.

Suddenly a speck of the loose dirt in the middle of her mound quivered, and a tiny hole appeared; she was hollowing it out from underneath and slowly packing it firmly back into the channel as she came up until now the door was falling in. She emerged gradually, slowly, packing the loose dirt back into the hole with all her legs and *punching it down with the tip of her ventrally curved abdomen*. She filled it in tight to the top, swept the dust back over it loosely, and departed promptly.

GROUP V.

19. *Pompiloides tropicus*, L.

She jumped into the hole which then lacked only half-an-inch of being full, bit away the soil from around the edge of the irregular hole, and dropped it in. . . . At last we could creep close enough to see her *smoothing down the filling in the hole with her abdomen*, but in a strange way quite new to us. The abdomen was curled under the body, making the dorsal surface of the tip appear ventral; this convex portion, pressed against the ground, proved a very efficient sad-iron, smoothing out and at the same time compressing the loose soil. When the filling was packed into the hole up to within one-eighth inch of the surface level, she kicked in some dust. . . . She then kicked all of the little clods of grey earth in a heap on top, went a few inches away and made another neat pile of exactly the same kind, then kicked more loose dust over the hole, completely covering it, and also flung in any stray lumps, large or small, that lay near. When they were too large she *carried them in her jaws and loosely dropped them* on the site of the nest. *At no stage did she attempt to compress the mass on top with her abdomen; it seems that this treatment is reserved for interior work.*

20. *Pompilus fuscipennis*, St. Fargeau.

After the egg was laid the wasp came up to the edge of the hole, and drawing in some earth with her mandibles began to dance up and down upon it, *jamming it into place with her abdomen*. Afterwards she came up higher and drew the dirt in with her first legs, not getting out of the hole until it was entirely filled up. Then began a remarkable performance. Bracing herself firmly on her legs she *used the end of her abdomen as an instrument*, and with it she now pounded the earth, now rubbed it, like a pestle in a mortar, and now used it as a brush to sweep away loose dust. Sometimes she would throw a little earth back under her body with her mandibles and rub it down with her abdomen. This part of the work being finished, she spent a few minutes in sweeping the ground with her first legs, and then brought a quantity of small objects and placed them over the nest. . . . This artistic finishing up of her duties recalled *Ammophila*, but among our subsequent examples of *fuscipennis* we never saw one do her work with such nicety . . . they sometimes brush off the surface without any rubbing or pounding.

GROUP VI.

21. The genera *Macromeris*, *Paragenia*, *Pseudagenia*, are mason wasps, having advanced beyond the digging stage. They build cells out of clay or other earth-like material. . . . The method of building cells is here distinctly different from that employed by the other mud-dauber wasps, as *Sceliphron*, *Pison*,

Trypoxylon, etc., for where these latter spread on the mud with the mandibles, sometimes aided by the forelegs, Pompilids *use the end of the body for this purpose, bending the abdomen under the thorax in an ungainly manner.*

22. *Ageniella banoensis*, Rohwer.

Builds her mud cells in a hole in the ground. . . . Operates like the rest of her cell-making tribe. On this occasion she was gathering mouthfuls of moist soil . . . to seal up the entrance to her burrow, *using the end of her body as a plasterer.*

23. *Paragenia argentifrons*, Smith (making its cells inside a bamboo).

The cells . . . are composed entirely of mud. . . . This mud, gathered by the jaws of the wasp, is turned over and over in her mouth-parts until it assumes the right consistency, when, lowering her head and at the same time bending the abdomen forward beneath her until its dorsal tip pierces the ball of mud, now almost touching the bamboo, she applies part of the mud to the wood, where it is *spread on as desired with the dorsal end of the abdomen.*

24. *Paragenia nyemitawa*, Rohwer.

(Explanation of a figure.) The wasp is revolving a semi-liquid ball of gum in her mouth, and is smearing a bit from this gum on the top of the nest with *the dorsal tip of the abdomen.*

25. *Pseudagenia caerulea*, Williams.

She commenced sealing up the cell, *using the tip of her abdomen* as a trowel.

GROUP VII.

26. *Pompilus analis*, Fabr.

This wasp is particularly interesting on account of the loose funnel-like depressions she makes in the soil to store her spiders in. . . . I saw her *excavating*. She would drag about large pieces of debris, then using her forelegs would dig with vigour in the loose soil and thereafter *tamp down the slight excavation formed*, by thumping it strongly and with vibrating speed *with the tip of her abdomen*. The final result was merely a shallow funnel-like depression, and in such a cavity as this she buries her spider.

27. *Pompilus scelestus*, Cresson.

She at once returned to the nest and began to make it larger. Standing in the tunnel with her head down and her abdomen curved under she bit the earth loose with her mandibles and *pushed it under her body and beyond the tip of the abdomen*. When a little had accumulated she backed out, *holding it in this way.*

GROUP VIII.

28. Undetermined species, medium-sized, black, with blue-black wings.

My attention was caught by a Pompilid with a big hunting spider, and when I first saw it, it had apparently just found it and was stinging it. Suddenly the spider escaped, and the Pompilid hurriedly half-ran, half-flew, up to it and caught it. The spider then remained absolutely motionless on a leaf in an attitude suggesting complete subservience to the Pompilid. . . .

The Pompilid *appeared* to be trying to sting it, when the spider suddenly rushed away again, hotly pursued by the fossor, which soon caught it. This time the spider hung from the under surface of a small leaf, and the Pompilid again appeared to be feeling for a soft place to sting, when to my great astonishment it suddenly flew away, apparently having done all it wanted to. The spider hung absolutely limply, as if in the usual semi-paralysed condition. But on examining it I found the Pompilid had *deposited an elongate ovum* on the side of the spider's abdomen. . . . Moreover, the spider was in no way paralysed, and, when I boxed it, was as active as ever, and when I got home leapt out of the box. . . . This looks as if we had here a Pompilid of such degraded habits that it has lost the art of stinging its prey to immobility and burying it, and just lays an egg on the external surface while the prey is still at large, like a Tachinid or Proctotrupid—*becoming, in fact, merely an ordinary parasite.*

GROUP IX.

29. *Pompiloides tropicus*, L.

See part of record 19.

30. *Psammochares melas*, Klug.

Early one morning I see her . . . sealing up the mouth of a crevice. . . . *Fragments of brick are lying about, and these are being used to block the hole.* Whatever is available is dragged to the aperture, both the tiniest pebbles and the bulky nodules. . . . She seems to collect them with a little circumspection, taking them from the débris in the near vicinity and fitting them carefully into the gate. At intervals she also kicks in the dust so as to fill the chinks between the fragments of her barrier and make it flush with the surrounding soil.

B. RECORDS OF SPHECIDAE.

GROUP I.

31. *Sphex ichneumonea*, L.

It began to draw the sand back into the hole, *scratching it in quite briskly* by means of its spiny fore tarsi, while standing on its two hind pairs of legs. It thus threw in half an inch of dirt upon the grasshopper, and flew off.

32. *Sphex viduatus*, Christ.

Elle en était sortie presque aussitôt, et avait commencé à fermer son nid, en y repoussant avec les pattes les déblais qu'elle en avait extraits, lorsque je l'ai prise.

33. *Sphex lobatus*, Fabr.

On emerging she takes a stand over the entrance, *shuffles back the sand* into the tunnel and thus seals the open gate. This last is a rapid and skilful operation: the soil is loose and she is an expert at the work. In a few minutes the gateway is sufficiently closed, and, satisfied with this, she disappears.

34. *Sphex latreilli*, Lep.

Le Sphex a soin, en sortant, de boucher l'ouverture de son terrier en la couvrant avec ses pattes, de la poussière qui l'entoure.

35. *Ammophila (Eremochares) dives*, Brullé.

La clôture du nid . . . se fit ensuite selon le processus habituel; il faut pourtant noter que les matériaux tels que pierres et débris végétaux n'abondent pas dans les environs, l'*Ammophile* utilisera pour la clôture de son terrier le sable humide extrait du premier trou, qui trouvait ainsi sa raison d'être naturelle.

36. *Ammophila haimatosoma*, Kohl.

La clôture de ce dernier eut lieu ensuite suivant les rites habituels. La Guêpe grattait les bords escarpés du silo pour en combler le puits, quelquefois s'adressait à d'autres éléments: *petites pierres*, mottes de terre, etc., qu'elle transportait au nid et coinçait dans le conduit.

GROUP II.

37. *Ammophila heydeni*, Dahlb.

. . . l'une achevait de fermer son nid en remplissant le puits vertical qui y donne accès. Elle y apportait des *petites pierres* et des mottes de terre trouvées autour de l'orifice, et les plaçait avec soin sur celles déjà établies. Parfois elle grattait le sol avec ses mandibules, et recueillait la poussière ainsi produite pour remplir les vides existant entre les moellons.

38. *Ammophila hirsuta*, Scop., var. *mervensis*, Rad.

On peut voir alors en effet ces insectes, comme déroutés, terminer leur nid à la hâte, et l'abandonner après l'avoir grossièrement clôturé. Mon *Ammophile*, au contraire ferma le sien avec soin, ne négligeant aucune des précautions qu'elle prend d'habitude. Elle tassait fréquemment le sable qu'elle venait de projeter dans le terrier, et elle en égalisait la surface en la frottant avec la face antérieure de ses mandibules comme les *A. sabulosa* et *campestris* observées par Adlerz (Lefnadsförhallanden och instinkter inom familjerna POMPILIDAE och SPHEGIDAE III (K. Svenska Vetensk. Akad. Handl. Stockholm, 1910).

GROUP III.

39. *Ammophila hirsuta*, Scop. (*viatica*, Sm.).

It came out and proceeded to fill the hole up. It stood with its tail just touching the mouth of the hole, and with its anterior legs it scratched the sand with such force as to send it flying backwards several inches into and beyond the hole. Occasionally it would take a large pebble in its mandibles and drop it in. Then it would ram it all down with its head, producing at the same time, by slightly and quickly vibrating its abdomen, a shrill noise. This it always did whenever it rammed the stuff down. After it had filled up its hole in this way it piled up a small heap of stones on top and then flew away.

40. *Ammophila*, sp. undetermined.

I saw a Sphegid at work—one with long pedicellated abdomen and very thin. I saw it carry up to its hole a small brown caterpillar, put it on the ground close by the hole, go down tail foremost, and drag in the prey after it. When it came up again it filled up the hole with, relatively, quite large pieces of stone and earth which it took up in its mandibles and rammed down. To finish up with, it scratched some loose sand over the orifice of the hole which was then indistinguishable from surrounding soil.

41. *Ammophila lugubris*, Gerst. (recorded as *beninensis*, Pal.)

After a remarkably short pause for egg-laying she came out and filled up the hole in the usual way by *biting off small lumps of soil* and putting them down, but *using very little indeed the method of scratching loose soil backward*.

42. *Ammophila lugubris* (probably).

After a short pause she came out again and started filling up the hole in the usual way when I bottled her.

43. *Ammophila lugubris* (probably).

She then dragged the second larva down in the same way and filled up the hole as usual.

44. *Ammophila polita*, Cresson.

Emerging after a few minutes she placed a small pebble in the doorway, which was thus partly closed, and flew away. She brought three more caterpillars at intervals of about thirty minutes, and then, *after wedging a pebble into the neck of the opening*, she began to fill it in solidly, scratching in dirt and *packing in lumps of earth* which were brought in her mandibles. We did not allow her to complete this operation. . . .

45. *Ammophila heydeni*, Dahlb.

Elle a commencé à *prendre des graviers avec ses mandibules* et à les faire tomber dans le trou pour le combler. De temps en temps, elle se retournait et, avec ses pattes, rejetait de la terre dans le trou.

46. *Ammophila sabulosa*, L.

L'Ammophile s'occupe à clore la demeure avec de grandes précautions. Les *pierrailles* utilisées pour la fermeture provisoire, avant la chasse, sont *réemployées*. Mais, cette fois, elles ne sont pas jetées pêle-mêle, sans liaison. Chacune d'elles est maintenant *placée avec soin*, poussée, calée, les intervalles bouchés à l'aide de *parcelles terreuses écrasées* sous l'effort de *compression des mandibules*. D'assise en assise, toute la galerie est comblée jusqu'au niveau du sol. La dernière couche de terre est particulièrement pressée.

47. *Ammophila urnaria*, Cresson.

The wasp first put a plug well down, then *dropped in several large pellets*, and brushed in a quantity of fine earth.

48. *Sphex cyaniventris*, Guérin.

Il vint enfin essayer la large pierre qui couvrait l'orifice à son arrivée avec la proie, mais il la soulevait à peine. *Il la posa sur le trou*, qu'elle boucha incomplètement. Il remarqua aux côtés des fentes *sur lesquelles il plaça des graviers*. Pour terminer, il rejeta avec ses pattes postérieures et intermédiaires une pluie de sable sur le tout.

49. *Sphex urnaria*, Dahlb.

When she emerged she again filled up the entrance by *placing therein the bits of wood and coal and pebbles* she had removed in opening it and then digged sand in upon them. When she had completed her task I captured her.

50. *Sphex vulgaris*.

When the provisioning of the nest was finished to her satisfaction she closed the opening of her burrow by kicking a lot of earth into the mouth of the tunnel, pushing in the earth for some distance. Then, after carefully smoothing the surface, she made a series of short flights in her peculiarly graceful fashion, each time *bringing a selected fragment of dry earth*, a lump half the size of a pea and *dropping these*, with a few bits of weed stem that she found, on the freshly disturbed earth in order to conceal all traces of excavation.

(N.B.—This record would perhaps come more fitly under Group IV.)

51. *Sphex marginatus*, Sm.

After the wasp had dragged in its prey it did quite a lot more excavating, eventually finishing up by *wedging four small stones firmly in the mouth*, and scratching some loose earth over all.

GROUP IV.

52. *Priononyx thomae*, Fabr.

"She came out and began to fill in the dirt. After this, for many minutes she *carried large cinders and placed them over the site*. . . . Sixteen minutes later she stopped piling cinders and for two minutes walked . . . then she came back to the very spot and *critically added more cinders* . . . and finally flew off."

53. *Priononyx thomae*, Dahlb.

She came out and filled her hole carefully, first by *carrying in mouthfuls of soil and precisely arranging it* on the inside, and then kicking more dirt in and going in after it to *pound it down, making a loud hum* as she pressed with all her strength against the tightening soil. . . . When the task of filling and covering was done, *several cinders* . . . *were brought in the mandibles* and placed over the spot.

54. *Sphex vulgaris*.

See last part of record 50.

55. *Ammophila gryphus*, Sm.

My attention was attracted to the peculiar actions of a handsome female of *Ammophila gryphus* . . . it alighted in front of me on a bare spot, about a foot square . . . for a minute or two it ran briskly about in every direction, the head close to the ground and the abdomen elevated, while its antennae were in constant agitation, as if searching for something important. . . . Suddenly it stopped at a certain spot, pressed the head close to the ground, and commenced *beating the ground with its abdomen*, producing at the same time an audible and *quite sharp sound* . . . tapping with each sound the earth with its abdomen. . . . After this was repeated three or four times it ran about again for a moment and then flew away. In a very short time it returned . . . and went through the same performance for several times like before. After it got through with these ceremonies it ran a short distance and *picked up with its mandibles a small pebble*, carried it to the mysterious spot and deposited it on top of that, *pressing it*, at the same time down as much as possible to insure its remaining in position. Running then again a

short distance it picked up another pebble and placed it close to the first one : after awhile a third was added. . . . Running about . . . for some time in search for a more suitable stone, but not finding what was wanted, she returned to the *little monument of pebbles*, commenced to rearrange and to *press them again down as much as possible*. After being satisfied that everything was well done she flew away, not to return. (The observer subsequently excavated beneath the pebbles and found a "fully grown larva of *Heterocampa subalbicans*, Pack., with an egg on it.")

GROUP V.

56. *Sphex ichneumonea*, L.

She began to throw earth into the nest : after a little while she went in herself and we could plainly hear her *humming as she pushed the loose material down with her head*.

57. *S. (Chlorion) ichneumonea*, L.

I saw one of the wasps on the 12th of July filling up her burrow, throwing in the dirt a little at a time, and *pounding it down with her head*. While the pounding was in progress she made a *buzzing noise*, which first attracted my attention.

58. *Psammophila violaceipennis*, Lep.

After oviposition the wasp emerges from the nest and seals up the entrance, in doing which she digs a quantity of sand down into the opening and then *rams it down with her head*, repeating the performance until the opening is completely filled up.

59. *Sphex occitanica*, Lep.

L'hyménoptère est occupé à clore son terrier, où la proie est emmagasinée et la ponte faite. Avec les tarses antérieurs, il balaie à reculons le devant de sa porte et lance dans l'entrée du logis un jet de poussière, qui lui passe sous le ventre et jaillit en arrière en un filet parabolique, aussi continu qu'un filet liquide tant est vive la prestesse du balayeur. Le *Sphex*, de temps à autre, *choisit avec les mandibules quelques grains de sable*, moellons de résistance qu'il intercale un à un dans la masse poudreuse. Le tout, pour faire corps, *est cogné avec le front, tassé à coup de mandibules*. La porte d'entrée rapidement disparaît, murée par cette maçonnerie.

60. *Priononyx thōmae*, Fabre.

She then, like *Ammophila* again, backed down the tunnel and pulled the locust after her. In a minute she reappeared and immediately began to close the tunnel. Scratching in pebbles and dust, she *tamped them down with her head*.

61. *Priononyx atrata*, St. Farg. [*atratum*, Lep.]

Priononyx filled up the tunnel by backing in, throwing in the soil at the same time, subsequently *using her head, more specifically, her clypeus and jaws as a packer or ram*.

62. *Priononyx atratum*, Lep.

While filling and packing in the earth, the wasp *stood on her head and pressed*

down the soil, producing with each stroke the shrill buzz. Next she brought large pellets from a distance and dropped them on the depression.

63. *Ammophila urnaria*, Cresson.

Filling the neck of the burrow with fine earth which was jammed down with much energy, this part of the work being accompanied by a loud and cheerful humming.

64. *Ammophila procera*, Dahlb.

Dry leaves and twigs were dropped into the hole and sand scratched in on top of these while all was stuffed down with the head.

Not only is débris thrown into the nest but the wasp alternates by scratching in the loose sand at the surface and tamping it down with her head.

65. *Ammobia mutica*, Kohl.

In plugging up her burrow temporarily, the wasp scrapes in the dirt with her forefeet and tamps it down with her head.

66. *Ammophila (Psammophila) tydei*, Guill.

The wasp is now industriously engaged in sealing up the tunnel. First it spreads a roof over the buried chamber . . . for this it selects what is suitable from the soil around. A bulky pebble or a few flat laminae of slate serve the purpose and are pushed down into the pit. The wasp follows, moulds them into place by the pressure of her head until the cell is closed. The roof secure, any material serves to block the tunnel. Surrounding débris . . . is shuffled indiscriminately down the passage. . . . All it needs is to be pressed tight. . . . Down goes the insect's head, the legs clutch the sides of the tunnel, the wings vibrate, and, with the vertex as a ram and all the strength of the body as a driving force, the loose particles of crumbling earth are compressed into a solid mass.

GROUP VI.

67. *Priononyx atratum*, Lep.

She reappeared and began at once to fill in the hole by first kicking in a small amount of dirt and then getting into the hole and working this earth down solid with her head, buzzing shrilly as she rammed it down. Sometimes she would break off clods or chunks of earth to fill in; these were not carelessly dropped but crushed to powder and packed tight with the head.

68. *Priononyx atratum*, Lep.

She scrambled out and scooped in a few armfuls of dirt, arranging each load slightly but packing it little. As the channel filled she tamped the dirt down more. . . . With her head she packed it constantly tighter as she neared the top. When the depression was nearly full she stopped taking the loose earth, but bit up chunks of firm, fresh, dirt which she carried in her mandibles and broke to pieces on the site. . . . The wasp pounded and buzzed and laboured for fourteen minutes, packing dirt in the depression until the ground was so hard and smooth that no trace of a hole remained. She stood squarely on her head, pushing downward so hard that twice she started to turn a somersault and just saved herself with difficulty; after that experience, she ingeniously altered her position for pounding. . . .

69. *Sphex (Ammophila) pictipennis*, Walsh.

She emerges head first and immediately gets some small clods, usually about three, and takes them down to the bottom. We suspect that she arranges these to serve as a partition between the chamber and the burrow, to prevent the loose soil from being packed down around the caterpillar or crowded upon the delicate egg. Then she jumps out nimbly and scratches and kicks the loose dirt nearby into the hole, goes in and *stands on her head, pounding and packing it down*. With each ram of the head she emits a shrill buzzing sound. . . . When the depression is yet about one-fourth inch deep, she fetches a large, firm clod . . . and throws it into the hole. . . . She grasps the clod firmly in her mandibles, and, for a minute or so, she rubs and *grinds it fiercely against the bottom of the depression, with a rotary or side-to-side motion*, until, under the pressure and wear, the clod crumbles and is worn to dust and becomes part of the compact filling. She then turns round and round on top of the hole, sweeping to the centre the dirt which has been pushed out at the edges of the saucer-shaped depression, fetches another clod from somewhere within a distance of two or three feet from the hole and repeats the performance . . . until the top of the fill is level with the ground. In this way she works the fill down much tighter, for we have often seen her use several pellets and pound them in after the hole appeared level full. In her next selection she seems to be more particular. She goes here and there, pausing at clods and tiny pebbles, sometimes lifting them or turning them over. When finally she finds one which suits her fancy, usually a pebble a little larger than her head, but sometimes an unusually hard clod or bit of wood, she brings it *in her mandibles, and, grasping it firmly, she rubs, pounds, and hammers down the dirt on the top of the hole until all traces of the fill are obliterated*. . . . Her task . . . is now at an end; she throws her tool aside a few inches and flits away. . . . She cannot be persuaded to use this tool before the precise time for it. Once we tossed her a tiny pebble while she was yet busy grinding to pieces her clods with a pestle-and-mortar motion, but she only took it, without ado, and laid it back on her rubbish heap. . . . Later on, when she was ready for her hammer, she went directly, and, to our great delight, *got our pebble* which she had so stolidly spurned a few minutes before. If, in grinding up the clods for filling, one does not readily go to pieces, she does not leave it in the hole for filling, but takes it out and throws it away. . . . In accomplishing the closing, she devotes about forty minutes of careful attention to a task which wasps of many other species finish in a few minutes. Here we have . . . a possible clue to the probable origin of the tool-using habit or instinct. We see her using first the loose earth, then clods with which to pack the earth tighter and more tight, and finally using some object one degree harder which will pack down the remaining dust on top of the hole, but will not go to pieces and leave more litter of its own on the site.

70. *Sphex pictipennis*, Walsh.

She came out again and immediately began to fill the hole. She carried in, one at a time, three clods of earth. . . . After that, for a few seconds, she kicked loose dust into the burrow. . . . After each portion she went in *to ram or pack it down*. . . . it sounded as if *with each ram of her head she notified us with a sharp buzz* of like duration. . . . There was yet about one-fourth inch of the burrow to be filled, when she came with a hard clod . . . threw it into the hole and went in herself as far as possible. . . . We were surprised to

see her *grasp the clod in her mandibles* and continuously, for three minutes, *press down the earth in the depression* with this tool, rubbing with it in a circular motion. But our surprise was greater when we saw her throw out this hard clod when she had tamped down the earth sufficiently; . . . a much smaller clod was then thrown in and beaten to dust with her head and face. . . . The question confronted us of how she would get dust to fill in the rest of the hole; . . . with her strong mandibles she dug up the hard earth nearby and kicked it in until the depression was full, and *packed it again with her head*. To accomplish this she almost stood on her head, bracing herself with her hind legs. . . . She next found a hard piece of clay a few inches away, and, using it as before, packed down the loose earth. After rubbing with this for five minutes she left it in the hole, dug up some more earth and kicked it over the site, quite covering this last tool, so she went back to the hole and *with her mandibles fished out this same clod and again used it* for one minute to pack down the last layer perfectly smooth and level with the surrounding earth. Then she laid the useful clod to one side. After an additional few seconds of dust kicking, to make the spot look exactly like the rest of the field, she flew carelessly away.

71. *Ammophila urnaria*, Dahlb.

In filling up her nest she put her head down into it and bit away the loose earth from the sides, letting it fall to the bottom of the burrow, and then, after a quantity had accumulated, *jammed it down with her head*. Earth was then brought from the outside and pressed in, and then more was bitten from the sides. When, at last, the filling was level with the ground, she brought a quantity of fine grains of dirt to the spot and picking up a small pebble in her mandibles, *used it as a hammer* in pounding them down with rapid strokes, thus making this spot as hard and firm as the surrounding surface. Before we could recover from our astonishment at this performance she had dropped her stone and was bringing more earth. . . . In a moment we saw her pick up the pebble and again pound the earth into place with it, hammering now here and now there until all was level. Once more the whole process was repeated. . . .

(Follows reference to following observation.)

72. *Ammophila yarrowi*, Cress.

When the excavation had been carried to the required depth, the wasp, after a survey of the premises, flying away, soon returned with a large pebble in its mandibles, which it carefully deposited within the opening; then, standing over the entrance upon her four posterior feet she rapidly . . . scraped the dust with her two front feet . . . back beneath her, till she had filled the hole above the stone to the top. . . . When she had heaped up the dirt to her satisfaction, she again flew away and immediately returned *with a smaller pebble*, perhaps an eighth of an inch in diameter, and then standing more nearly erect, with the front feet folded beneath her, she *pressed down the dust all over and about the opening*, smoothing off the surface, and accompanying the action *with a peculiar rasping sound*. After all this was done, . . . she laid aside the little pebble and flew away to be gone some minutes. (Then describes reappearance of wasp with a larva and re-opening the burrow). Next, the larva is dragged down the hole where the wasp remains for a few minutes, afterwards returning and closing up the entrance *precisely as before*.

73. *Ammophila procera*, Dahlb.

Hartman finds that with *A. procera*, at the end of the operation of closing the nest (cf. Record 64), it sometimes happens "that a piece of wood is pressed down tightly, then pulled out and pressed down again, and this repeated several times, so that one might suspect that the wasp were here *improvising a tool* with which to tamp down the sand."

74. *Ammophila*, sp. undetermined.

(The species noted was a "rather small species [which] selected a green Noctuid larva.")

She soon came out, replaced the lid (the lump of baked earth) and carefully scratched dirt upon it, *using her head to tamp it down* upon the lid. Then *picking up a small stick she packed the earth down a little*, after which she scratched more dirt over the place. . . .

A larger species was observed in the act of closing its burrow. . . . The hole, about six inches deep, was partly filled with sand-clay, and *Ammophila* was seen pressing the dirt down in the cup, *using as a tool* the tibia and tarsus of a small Acridiid (*Melanoplus*?). After this tamping work was over she placed a lump of dry earth and a small piece of lizard excrement in the depression. At the bottom of the burrow we found a Notodontid larva with an oblong egg on its side.

75. *Sphex* (*Ammophila*) *gryphus*, Sm.

In north-eastern Texas our attention, focussed on a decaying stump, was suddenly distracted by a loud buzzing behind us. We turned to see a Sphecid finishing her burrow by *tamping down the filling with a pebble*. The performance was not, however, being done according to Peckham. Our wasp pointed her abdomen directly upward and pounded with the tool held between her mandibles by *moving her entire body up and down*, thereby *simulating a pile driver* rather than a hammer. As soon as she had finished we captured her.

GROUP VII.

76. *Podium flavipenne*, Latr.

In closing up her burrow she chooses a spot only a few inches removed, moistens it with water, *gathers up a mouthful of the mud* and commencing work from some little distance down the mouth of the tunnel finally plugs it flush with the surface of the ground.

GROUP VIII.

77. *Sphex elegans*, Sm.

For nesting sites they prefer the larger stems, first gnawing through the thin partitions opposite the leaf insertions. . . . The parent wasp first packs the bottom of this tube with very fine, grass-like, fibres; which . . . prove to be fine strips of the loosely fibrous bark of *Audibertia polystacha*. . . . On this is laid the larval food supply which consists, on an average, of seven or eight tree-crickets. The egg is laid on the breast of one of the tree-crickets, a wad of bark fibre is placed on the top which forms the base for the next cell. . . . A copious wad, sometimes three or four inches in depth, protects the topmost cell.

C. RECORDS OF LARRIDAE.

78. *Astata leuthostromii*, Ashmead.

The wasp stood with her head peeping out of a hole that seemed too large for it, and occasionally *scrambled on the edges with her fore feet* as though she were trying to get out, although it may be that her object was to draw loose dirt down into the hole.

79. *Crotolarra pitamawa*, Rohwer.

The burrow is then closed, the wasp *bringing in bits of earth with her mandibles*.

80. *Notogonia argentata*, Pal.-Beauv.

She was very busy filling up her tunnel . . . gathering little lumps of earth and other material. . . . She frequently carried lumps of earth of at least her own weight. *None of this material is tamped down*, but lightly placed at the bottom of the tunnel. The *Ammophilas* and *Isodontias* among the SPHECIDAE, and many of the Larrids, pack the soil, at least when their burrows are nearly filled.

81. *Notogonidea (Notogonia) argentata*, Pal.-Beauv.

We discovered her putting in the dirt filling. She worked by kicking in the loose soil near the mouth of the hole with her front legs, and then, with the *ventral part of her abdomen*, she would *tamp it down and rub it smooth with a slow, grinding, circular motion*. (Cp. Williams' obs. on this species, Record 80. But Rau comments that in another case (p. 157) although "we found her carrying and dropping into the hole pellets, fragments of stones and leaves, upon opening the burrow we did find the gallery just above the chamber well packed with earth which she surely must have compressed, as another specimen showed, with the ventral part of the abdomen moving in a slow, grinding, circular motion.")

82. *Notogonia pompiliiformis*, Panzer.

"Lorsque le *Notogonia* a enfoui sa proie, il bourre l'entrée de son terrier avec des parcelles de terre, et, au besoin, de brindilles végétales qu'il *entasse sans les cimenter*; on le voit sortir précipitamment de son trou, aller à quelques centimètres de là, *saisir*, après quelques recherches, *un petit morceau de terre ou un minuscule caillou*, dans ses mandibules, et le ramener, toujours en courant."

83. *Notogonidea williamsi*, Rohwer.

I found one of these burrows, with the proprietress filling it up with *bits of soil*, which she carried and *manipulated with her mandibles*.

84. *Tachysphex tarsatus*, Say.

When the tunnel was nearly filled it was easy to observe in what manner the wasp works. Throwing in the dirt, she backs in and *vibrates* or shakes her whole body longitudinally against the latter, thus *pounding in the soil with the tip of her abdomen*. She would also sway her body from side to side while vibrating, with the evident purpose of embracing all the necessary area in the operation. This process reminds one of a *minute steam hammer at work*.

85. *Tachysphex terminatus*, Smith.

She closes her burrow with loose sand in a way very similar to *Bembex nubilipennis* (see Record 89); she emerges kicking the dirt under her into the burrow, and, after it is fully closed takes great pains to kick plenty of loose sand over the hole to conceal it completely. When one proceeds to dig it out one finds the sand so loosely packed in the channel that it can be readily tickled out with a grassblade.

86. *Tachytes*, sp. undetermined, preying on grasshoppers.

She proceeded to fill the nest, scratching the earth in with her first legs and *working it down with the tip of the abdomen*.

87. *Tachytes unicolor*.

In filling in burrow nibbles soil with mandibles and shuffles loose stuff into burrow backwards, using hind legs chiefly.

88. *Tachytes panzeri*, V. der Lind.

L'entrée est enfin bouchée, avec des moellons d'abord, qui empêcherent le ruissellement des remblais dans la chambre; puis avec de la poussière balayée, sous laquelle disparaît tout vestige de l'habitation souterraine. Maintenant c'est fini.

D. RECORDS OF BEMBECIDAE.

89. *Bembex nubilipennis*, Cress.

[Authors point out distinction between temporary and final closure.]

When the wasp has finished feeding the larva she emerges from the open hole but does not turn around and go right back in, head first, as previously. Instead of going in and kicking the dirt up from the lower part of the channel, she begins scratching and kicking the loose dirt from the surface into the hole behind her. . . . Then she runs to the hole, peeps in, turns around and backs in, kicking, scratching, clawing and crowding the dirt deeper down into the hole and out of sight. . . . Thus she continues until the hole is filled so near the top that she cannot back down into it any more; then she assumes the same position backwards on the hole and crams and packs the dirt down with her hind pairs of legs and pounds, *rubs and punches it down with her abdomen* . . . and repeats the packing process two or three times until the fill is brought up exactly level with the surface of the ground. *Having finished tamping the earth she begins sweeping all around.* . . .

90. *Monedula signata*, L.

When filling in, scratches earth from all round and beats it down with the tip of its abdomen.

E. RECORDS OF VESPOIDEA.

91. *Pterombus iheringi*, Ducker (SCOLIIDAE).

The enemies of the tiger-beetle larvae considered in this paper are solitary wasps that on biological grounds fit best among the SCOLIIDAE. As far as is known all the SCOLIIDAE attack the larvae of beetles. . . . From a standpoint of habits *Methoca* and *Pterombus* should be allotted to the same family, but the one has been placed sometimes with the MUTILLIDAE, and sometimes

with the THYNNIDAE, and the other among the SCOLIIDAE and the TIPHIIDAE. Both *Methoca* and *Pterombus* attack the grubs of CICINDELIDAE. . . . She grasps the underside of her heavy prey in her mandibles pushing it up to near the top . . . of the burrow so that . . . it naturally suspends itself, limp and straight and out of the way of the wasp below, that immediately sets about making the lower part of the cell. Bits of earth are gouged out from the sides and tamped down into the bottom with the extremity of her flexible abdomen. [Follows a description of the egg laying.] . . . The wasp has squeezed herself past the head and thorax of her prey, and now commences to plug up the burrow, biting off soil from the walls and tamping it down upon the armoured part of the Cicindelid larva. This tamping is done not so much after the manner of certain LARRIDAE, notably *Tachysphex* (see Record 84), which wriggles the abdomen, and vibrates the length of her body as a steam hammer; the process in the main is relatively slow, the abdomen of *Pterombus* elongates and telescopes, reaching out sideways and pushes and packs the soil almost as one might use the hand for that purpose. (See Record 12.) She also turns about, works the soil in her mandibles and pushes in with her head; her fore-legs scrape off a little earth, but biting is the chief means of detaching it, and as the hole becomes more shallow she deposits pieces at the bottom but does not tamp down at the last. One such cell measured 20 mm. long, the plug 13, and the unfilled top 9 mm.

F. RECORDS OF VESPIDAE.

92. *Odynerus rufobasilaris*, Ashm. (This wasp makes cells in hollow stems of a shrub.)

The cell divisions in one specimen are composed of the pith of the plant. In the other the partitions consist of thin discs of sand. The wasp, presumably after provisioning each cell, adds a quantity of sand before sealing it up, and this is afterwards utilised by the larvae in the construction of its cocoon.

REFERENCES TO OBSERVATIONS QUOTED.

The names are as in the original records.

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2. *Psammochares irpex*, Gerst. Carpenter, G. D. Hale. 1918, Proc. Ent. Soc. Lond., 1918: cxlv.
3. *Pompilus rufipes*. Latter, O. H. Observation dated 1907, kindly communicated to me by Mr. Latter in a letter dated Feb. 17th, 1930.
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5. *Pompilus quinquenotatus*, Say. Peckham, 1898, loc. cit., p. 130.
6. *Pompilus biguttatus*, Fabr. Peckham. 1898, loc. cit., p. 139.
7. *Pompilus scelestus*, Cresson. Peckham. 1898, loc. cit., p. 159.
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23. *Paragenia argentifrons*, Smith. Williams. 1919, loc. cit., p. 94.
24. *Paragenia nyemitawa*, Rohwer. Williams. 1919, loc. cit., p. 98.
25. *Paragenia caerulescens*, Williams. Williams. 1919, loc. cit., p. 100.
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39. *Ammophila hirsuta* Scop. (*viatica*, Sm.). Carpenter, G. D. Hale. 1913, Proc. Ent. Soc. Lond., 1913: c.
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64. *Ammophila procera*, Dahlb. Hartman. 1905, *loc. cit.*, pp. 15-16.
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SECTION III.

DISCUSSION OF THE RECORDS.

A. PSAMMOCHARIDAE.

GROUP I contains observations on the simplest possible process, in which loose earth is merely scratched back into the open mouth of the burrow. It will be noted in Record 3, however, that material is definitely gathered to conceal all traces of the work.

GROUP II. Here is a step in advance: the edges of the burrow are broken with the mandibles to provide loose material for pushing down with the legs.

GROUP III follows naturally as a development of II. Record 7 illustrates very beautifully how the use of the abdomen could have developed. As the earth rises up to come into contact with the end of the abdomen what more natural than that pressure, at first perhaps quite accidental, should come to be used "purposely" (it is difficult to avoid anthropomorphic expressions!).

GROUP IV. Here we see the specialisation of a proceeding which was probably at first quite accidental. The abdomen is used as a definite instrument for a special purpose, and in the most developed use of it the whole body is thrown into rapid to-and-fro vibratory movement. The likeness of this movement to that of a mechanical instrument has struck two observers independently. (See Records 14, 15, 17.)

GROUP V. This group exemplifies the use of the abdomen in a somewhat different manner, more like that of a smoothing tool. This method is of especial interest as leading up to Group VI. Notice should be taken of the closing remark of Record 19; the reason would appear to be found in the remark on Record 7 under Group III above. The "feel" of the earth around the end of the abdomen may be the stimulus which causes the ramming movement.

GROUP VI. These records surprised me very much as I had no previous

idea that such a habit existed. It is, however, clearly explained by previous records which lead up to it through Group V. One would imagine that the Sphecid method, so well exemplified by *Sceliphron*, but also familiar in Vespoid "Mud-wasps," would be much more efficient, but, owing to their ancestry, *Macromeris* and allied genera are forced to use the abdomen to smooth out the mud. It would be of extreme interest to know whether any trace of the ancestral habit of using the abdomen can be found among other Vespoids than the PSAMMOCHARIDAE, which have completely given up the use of earth.

GROUP VII. Here the use of the abdomen appears to have been carried beyond the end of the cycle so that it reappears at the beginning, when it aids in the process of making the burrow. The use of the abdomen to help removing soil from the burrow (Record 27) is not recorded for any other species. Record 26 shows an interesting stage, when merely a slight depression is made, which leads up to a group (GROUP VIIa) of which I have not quoted any records. In this there is no digging at all, but the prey is bestowed in some niche or crack or left in its own burrow.

GROUP VIII. I have only one record in this group. The wasp seems to behave like one of the "Parasitic" species which merely lays an egg upon the prey and leaves it in the open, taking no trouble either to sting it or conceal it. More observations are much needed to show whether this is as exceptional as it seems, or whether a well-defined group can be established. It is, however, possible that a sting is inflicted, whose effects last for only long enough to keep the spider quiet while the ovum is deposited.

GROUP IX. This group is a development of a habit noticed under I, Record 3. Pieces of material are collected and put into place with the mandibles. This habit reaches its maximum development in the SPHECIDAE.

B. SPHECIDAE.

GROUP I. This corresponds with Group I of the PSAMMOCHARIDAE, illustrating the simplest possible process. The later records, however, show a transition to the process of "building" described under Group III-IV below.

GROUP II. An interesting procedure is here shown: the wasp produces, by the use of its mandibles on the surrounding soil, loose earth which is subsequently scratched into the burrow. It can easily be understood how the use of the mandibles has developed into the process of biting out pieces of earth which are then put into the hole (Group III and VI).

GROUP III. In this group is particularly well exemplified the habit of taking pieces of material in the mandibles and pushing them down the burrow. In some cases (e.g. Record 41) very little use is made of loose earth. Record 46 shows how the process almost becomes one of building with pieces of stone. It seems likely that from this putting into place with the mandibles arose the habit illustrated in Group V.

GROUP IV. The process of building has in this group been carried so far that a small erection of pieces of solid material is piled over the closed burrow. Many *Ammophila* make a great point of putting a few pieces of material on the spot, but Records 52, 53 and 55 show this process very highly developed. The first part of Record 55 will be referred to later.

GROUP V. Here is seen the most characteristic feature of the Sphecid habits, the ramming in of loose material with the front of the head. Record 61 shows very clearly how this process could have developed from the habit of

taking pieces of material in the mandibles and putting them into place. Record 66 gives a very graphic picture of the operation.

It is at this stage of the proceedings, in particular, that the "song," as Fabre dubs it, is heard. Many times one's attention is first drawn to a Sphecids at work by hearing the "loud and cheerful humming," or "shrill buzz," of an insect out of sight in the burrow. It appears that the noise is produced by telescopic movements of the segments of the abdomen: I find in one of my old notes, which I had forgotten, that the noise appeared to be produced in this way, and a note which Mr. K. G. Blair kindly sent me showed that he "evidently considered the point, as to how the noise was produced, whether with the wings or the abdomen, and decided that the in-and-out vibrations of the latter were responsible."

The noise appears to be particularly connected with the use of the mandibles and head; it becomes louder and more furious as the Sphecids wrestles with some particularly refractory material which it is trying to bite out as it excavates. I remember well one *Ammophila* which brought out of its burrow from time to time "armfuls" of loose earth held between the front legs and the head, and each time the load was deposited a short shrill buzz, as if of satisfaction, was made.

Psammocharids also may be heard to make a noise like this, but it is, I think, especially the habit of Sphecids. (See also a Note after the observations on Group VIII.)

GROUP VI. A most interesting development is here shown, whose origin is, I think, quite clearly revealed by Records 67 and 68. A piece of material is bitten out, as in Group V, ready for putting down the hole, but it breaks into dust and this is then packed in with the head. In Record 69 we see that the wasp first builds a partition and then takes a piece of friable material and deliberately grinds it down in the burrow. The next step is to take a more solid object, a pebble, and use it as a hammer. Record 70 shows most interestingly how the wasp towards the end deliberately selects a certain object for this use, and Record 73 leads up to 74 in which a piece of foreign material, not in itself utilised for filling up the burrow, is employed for the purpose of ramming down the loose soil.

I would direct especial attention to Record 75; the Sphecids, utilising the pebble held in her mandibles as a rammer, throws the body into the same rapid to-and-fro movements as the Psammocharids noted in Records 14 and 17.

GROUP VII. The single observation on *Podium* (which is related to *Sceliphron*) shows a departure in a new direction which has apparently resulted in the well-known "mud-daubing" procedure of *Sceliphron*. Note that *Podium* only uses mud at the end of the process of closing its burrow; the first part is probably closed by loose earth in the usual manner. It would be very interesting to know whether a similar transition between diggers and builders can be traced among VESPIDAE.

GROUP VIII. In this group may be placed species which are no longer "Fossors" but have found it more convenient to make their nests inside hollow stems. A parallel exists among the bees, such as *Osmia*, with which SPHECIDAE are allied. In this connection a note by Dr. R. C. L. Perkins, F.R.S., who kindly replied to a request for personal observations, may be quoted here. "Bees which specially close the burrows use the mandibles in doing this, whether the material for closing them be vegetable or earthy. Possibly the head is also sometimes used, as it is frequent to find the face with more or less clay stuck on." It appears that here is an interesting field for

further observation; to trace the evolution of a fossorial habit into a habit of nesting inside ready-made cavities. The record which has been quoted for this group is that of a Sphecid which has completely given up the use of earth. But there are others which utilise a certain amount like the Vespids quoted in Record 92. I have not attempted to collect more records in this group which is rather beyond the main point discussed in this paper.

Note.—A most curious and unique observation on *Ammophila gryphus* is recorded under 55. The wasp, while in a state of considerable agitation hunting about, frequently tapped the ground with its abdomen. This can, I think, be explained merely as an expression of agitation; it seemed to be searching for a pebble with which to carry out its final manœuvre. It will be remembered that it has been previously pointed out that the use of the head and mandibles is particularly associated with the production of the loud buzzing noise. In this case, the wasp was apparently highly excited by the urge of an impulse (as yet unfulfilled) to pick up a pebble in its mandibles, and it is interesting to note that the observer mentions "an audible and quite sharp sound."

C. LARRIDAE.

It was not my original intention to include LARRIDAE (about which I knew nothing) in this paper, but the records that were found during the search are of such interest that I have done so. They reveal habits analogous to those of both Psammocharids and Sphecids. Thus, Record 78 may be compared to 3 and 4; 79, 80 and 83 with 41 or 47; 81 with 19 and 20; while 84 corresponds beautifully with 12 and 17. But inasmuch as there are no records of a Larid using the front of the head as a rammer, while Psammocharids do sometimes put pieces of earth into place with the mandibles, the habitudinal relationship of the LARRIDAE must be considered to be with PSAMMOCHARIDAE.

D. BEMBECIDAE.

Record 89 is remarkably interesting, and the only one I could find showing how a Bembecid finally fills up its burrow. But a note which Mr. Richards kindly sent me provides a second instance. I have never witnessed this. Many more records are needed, to show whether the use of the abdomen is habitual where the burrow is finally closed over a full-fed larva. The method seems to be analogous with that recorded under 19 and 20 rather than the more rapid movements recorded under 12 and 17.

E. SCOLIIDAE.

The single observation that I found, bearing on the subject of this paper, is an interesting one, showing the same method as that characteristic of Psammocharids, such as that alluded to under Record 12, and also the use of the head as in the Sphecids. It is obvious that further observations on Scoliids would be of much interest.

F. VESPIDAE.

An observation on *Odynerus* has been included here because it illustrates very nicely a transition stage of which I have quoted no record in the SPHECIDAE. The use of earth has shrunk to its minimum; the wasp merely introduces a little into the hollow stem to form partitions which are subsequently utilised by the larva in the process of cocoon making. The further stage, in which the use of earth has been altogether abandoned, is shown by Record 77.

SUMMARY.

The conclusion that, when filling up their stocked burrows, wasps of the family PSAMMOCHARIDAE ram the loose earth down with the abdomen, never using the head, while SPHECIDAE use the head and never the abdomen, has been firmly established by records of 28 observations on 25 species of Psammocharids by 9 authors, and of 46 observations on 31 species of Sphecids by 21 authors. Suggestive lines of inquiry among VESPOIDEA are opened up by the records of certain cell-making Psammocharids, and among APIDAE by certain Sphecids. Two observations on BEMBECIDAE show that they, like Psammocharids, use the abdomen when finally closing the burrow, while LARRIDAE, though in certain respects resembling Sphecids, are in their habits more like Psammocharids. A single observation on a species of SCOLIIDAE shows that it uses its abdomen like a Psammocharid, but also introduces material with its mandibles like a Sphecid. More observations on these last three families would be of great interest. It is shown how the specialised use of the abdomen as a hammer could have arisen by easy stages, and how the use of a stone as a hammer could have gradually developed.

MICROLEPIDOPTERA OF MAURITIUS

By EDWARD MEYRICK, B.A., F.R.S.

[Read June 4th, 1930.]

ABOUT 30 years ago Monsieur L'Abbé J. de Joannis placed a box containing about 120 specimens of Microlepidoptera from Mauritius in the hands of the late Lord Walsingham for study. Lord Walsingham attached tentative names to a few species, and the box was then put on one side and seems to have been totally forgotten. In September last Mr. H. Stringer of the British Museum discovered the box, and restored it to M. de Joannis when visiting the Museum. By a rare coincidence I happened to visit the Museum the same day, and M. de Joannis asked me to undertake the examination of the specimens. Some further delay subsequently took place, whilst M. de Joannis was obtaining for me some 50 additional specimens from the same collector, but the whole collection has now been studied, and forms a very considerable addition to our knowledge of the fauna.

In *Trans. Ent. Soc. Lond.* 1887 I described 3 species from Mauritius, taken by myself three years earlier when spending a few hours there on my third voyage to Australia; and in the *Transactions* for 1910 I dealt with a small but very interesting collection made by my friend the late Colonel N. Manders during a short residence. No other information seems to have been published. I have therefore thought it well to include these results with the present paper, making it a complete (but undoubtedly very imperfect) catalogue of this part of the fauna. Full synonymy is not given. Taken in conjunction with my papers on the Microlepidoptera of the Seychelles (*Trans. Linn. Soc. Lond.* 14, 1911), and of Rodriguez (*Trans. Ent. Soc. Lond.* 1923), it will be found to indicate a highly peculiar association, formed on a very narrow basis, yet not including very primitive types.

The specimens forming the material for the present paper were collected (except where otherwise stated) by Monsieur Paul Carié, and the types are deposited in the Muséum d'Histoire naturelle de Paris; I am much indebted to M. de Joannis for permission to retain co-types. Collector's details are somewhat meagre, but are recited so far as available.

PTEROPHORIDAE.

Trichoptilus wahlbergi, Zell. *Linn. Ent.* 6: 346 (1851).

Ranges from Africa and India to Australia.

Sphenarches caffer, Zell. *Linn. Ent.* 6: 348 (1851).

Occurs throughout the African and Indo-Malayan regions, also in Australia and the Pacific Islands.

Platytilia brachymorpha, Meyr. *Trans. Ent. Soc. Lond.* 1888: 240.
Africa, India, China, Australia, Hawaii, N. America (*Manders*).

Platytilia censoria, Meyr. *Trans. Ent. Soc. Lond.* 1910: 367.
Endemic (*Manders*).

TRANS. ENT. SOC. LOND. 78. PART II. (DEC. 1930.)

Platyptilia molopias, Meyr. J. Bombay Nat. Hist. Soc. **17**: 135 (1906).
African and Indo-Malayan regions, Madagascar.

Pterophorus lienigianus, Zell. Linn. Ent. **6**: 380 (1851).
Nearly cosmopolitan.

Ochyrotica concursa, Wals. Ent. Mon. Mag. **27**: 241 (1891).
African and Indo-Malayan regions.

TORTRICIDAE.

Adoxophyes telestica, sp. n.

♂. 17–19 mm., ♀ 22 mm. Head, palpi pale reddish-grey. Thorax pale grey. Fore-wings suboblong, costa anteriorly moderately arched, ♂ with slender fold on basal fourth, then slightly arched, apex nearly rectangular, termen faintly sinuate, vertical; ♂ light grey, ♀ light rosy-brownish with whitish-violet gloss; markings violet-fuscous, darker in ♂, central fascia represented by an oblique transverse blotch from costa before middle and a spot on dorsum towards tornus, costal patch rather large, semioval, a series of several strigulae from middle of this to tornus, and some others towards termen: cilia ♂ violet-fuscous, on tornus pale greyish, ♀ violet-grey, on termen pale reddish-grey. Hind-wings grey; cilia pale greyish, a grey subbasal line.

3 ex., Curepipe, October; one labelled “mandarinier,” probably bred from *Citrus aurantium*. Nearly related to *ergatica* from Seychelles and Rodriguez, but distinct by darker cilia of fore-wings and grey hind-wings.

Tortrix sanidota, Meyr. Exot. Micr. **1**: 7 (1912).
Also from Comoro Islands.

Tortrix discruciata, sp. n.

♀. 23–24 mm. Head, thorax ochreous-whitish. Palpi ochreous-whitish, second joint tinged pale greyish-fulvous except apical edge. Fore-wings suboblong, slightly dilated, costa anteriorly moderately arched, then nearly straight, apex obtuse, termen hardly sinuate, slightly oblique; ochreous-whitish, strewn small or minute brownish or fuscous dots; in one example markings ochreous-brownish or fuscous with some blackish dots, a narrow fascia from $\frac{1}{5}$ of costa to middle of dorsum with angular posterior projection in middle, a very oblique broad irregular central fascia narrowed on costa and interrupted beneath this, two upwards-oblique streaks from this posteriorly above and below middle, and a semi-oval blotch on costa beyond middle, in the other all these markings are hardly indicated and practically obsolete: cilia whitish with traces of ochreous-fuscous bars. Hind-wings grey-whitish strigulated and spotted light grey.

♂. 23 mm. Similar to the strongly marked ♀, but fore-wings with strong costal fold from base to $\frac{2}{5}$, markings darker fuscous mixed red-brown, anterior fascia extended nearly to base, costa posteriorly dark with four small whitish spots, a terminal fascia of dark suffusion confluent dorsally with central fascia.

3 ex. A variable species, allied to the South African *acerbella*, Walk.

Tortrix ochnotoma, sp. n.

♀. 16 mm. Head reddish-grey. Palpi, thorax grey. Fore-wings moderate, posteriorly dilated, costa gently arched, termen straight, little oblique; light grey, indistinctly striated

transversely darker grey; a semi-ovate blotch of dark crimson suffusion on dorsum from $\frac{1}{4}$ to beyond middle, narrowed posteriorly; central fascia narrow, irregular, rather darker grey, from beyond middle of costa to before tornus, dorsal extremity suffused crimson; a triangular dark grey apical patch mixed dull crimson suffusion, edge straight, running from costa at $\frac{2}{3}$ to termen above tornus: cilia light grey tinged reddish. Hind-wings grey; cilia pale grey, a darker subbasal line.

1 ex., Curepipe, October. A peculiar form, not near anything known to me.

EUCOSMIDAE.

Spilonota routhia, Meyr. Trans. Ent. Soc. Lond. 1910: 368.

Also from South Africa, Ceylon, and India. Larva on *Psidium* and *Eugenia*, doubtless introduced.

Spilonota sinuosa, Meyr. Ann. S. Afr. Mus. 17: 2 (1917).

Also from South Africa and Rodriguez.

Cosmorrhyncha ocelliferana, Walk. List spec. Lep. B.M. xxviii: 408 (1863).

Also from South Africa, Madagascar, and South America. I think South America is the real home of this curious insect.

Lobesia aeolopa, Meyr. J. Bombay Nat. Hist. Soc. 17: 976 (1907).

Also from South Africa, Madagascar, and Indo-Malayan region.

***Polychrosis oxyperena*, n. sp.**

♂. 15 mm. Head pale grey, a dark grey bar on crown. Palpi pale grey, second joint with suffused darker bar. Thorax grey, anterior margin with suffused darker grey spots. Fore-wings rather elongate-triangular, costa slightly arched, termen bowed, rather oblique; whitish, whiter posteriorly, towards costa anteriorly tinged light brownish-ochreous; costa marked very small blackish strigulae; edge of basal patch formed by a nearly straight irregular grey striga thickened on costa and terminating in a blackish dorsal spot; central fascia dark brown, somewhat oblique, rather narrow, suddenly attenuated on costal $\frac{2}{3}$, beneath this projecting upwards posteriorly in a blackish triangular spot; immediately beyond this three large black dots on costal portion, and a small black spot in middle, then an interrupted narrow fascia of irregular blue-leaden markings, followed on costa by a rounded brown blotch containing a small blue-leaden costal mark; an irregularly triangular dark brown blackish-mixed blotch in disc before termen, touching it with one angle in middle, connected with tornus by a pale brownish-ochreous streak followed by an irregular blue-leaden streak; a small dark brown spot on costa near apex, lying within a furcate blue-leaden line running to termen beneath apex; a dark fuscous apical spot: cilia whitish partially tinged brown and irregularly barred dark grey. Hind-wings dark grey; cilia pale ashy-grey.

1 ex., Curepipe. Allied to *stericta*, Meyr.

Argyroploce peltastica, Meyr. Ann. Transvaal Mus. 8: 57 (1921).

Also from South and East Africa, and Seychelles. Bred from the bean *Canavalia ensiformis*, and probably introduced with this; also feeds on other Leguminosae.

Argyroploce leucotreta, Meyr. Ann. Transvaal Mus. 3: 276 (1913).

Also from East, West, and South Africa. Bred from peaches; feeds also on many other fruits and seeds.

Argyroploce socraticea, sp. n.

♀. 19 mm. Head, thorax reddish-grey mixed dark fuscous, face whitish. Fore-wings elongate, gradually dilated, costa gently arched, termen sinuate, hardly oblique; dark reddish-fuscous suffusedly mixed purplish-grey; costal edge dark fuscous with short paired whitish strigulae except towards base; a narrow red-brownish terminal fascia marked on lower half with a leaden-metallic streak (posterior edge of ocellus) preceded by three blackish dots and followed by an ochreous-whitish line; a fine dark fuscous terminal line: cilia red-brownish, above apex a dark brown bar. Hind-wings dark fuscous; cilia light greyish, a darker basal shade.

1 ex., bred from larva on *Tamarindus indica* (Leguminosae). Recalls *tetanota*, Meyr., but by form of wing rather allied to *halantha*, Meyr. May probably be an introduced species, but I am unable to recognise it.

Argyroploce schistaceana, Snell. Tijdschr. v. Ent. 34: 353, pl. xix, 7 (1891).

Also from Java and Malaya. Feeds on sugar-cane, and doubtless introduced with it.

Argyroploce symmictopa, sp. n.

♂. 17 mm. Head whitish-grey. Palpi, thorax light grey suffusedly irrorated whitish. Fore-wings elongate-triangular, costa gently arched, termen hardly rounded, somewhat oblique; greyish-ochreous, irregularly irrorated grey; costa marked with pairs of obscure whitish-grey strigulae; dorsal edge dotted grey; edge of basal patch hardly traceable, obtuse-angled in middle; costal edge of central fascia more distinctly greyish-ochreous, otherwise not traceable; ocellus indicated by obscure leaden lateral streaks, within it a shorter similar streak; an obscure leaden obtuse-angled stria from beneath costa about $\frac{2}{3}$ to below middle of termen, preceding this three or four small indistinct dark fuscous dots; an obscure leaden mark across apex: cilia grey, basal half whitish with grey subbasal line. Hind-wings grey; cilia whitish-grey, a grey subbasal line.

1 ex., Mare-aux-Vacoas, bred from larva on "herbe-à-mèche" (= wick-plant). Suggests a *Laspeyresia*, but palpi and neuration of *Argyroploce*.

MYSTOGENES, gen. nov.

Palpi moderate, curved, ascending, second joint shortly rough-scaled beneath, terminal joint very short. Thorax smooth. Fore-wings 2 from $\frac{2}{3}$, 3 and 4 near together from angle, curved and approximated to 5 at apex, 7 to termen, 11 from middle. Hind-wings with cubital pecten; 3-5 curved and rather approximated at base, 6 and 7 closely approximated towards base.

Mystogenes astatopa, sp. n.

♀. 12 mm. Head, thorax rather dark grey. Palpi grey. Fore-wings moderate, slightly dilated, costa gently arched, apex nearly rectangular, termen slightly sinuate, vertical; dark fuscous, tips of scales whitish, forming a fine transverse striolation; costa with small blackish spots, posteriorly blackish with three or four indistinct hardly double small whitish oblique strigulae, and a single small distinct strigula before apex; very oblique blue-leaden strigae from costa about middle and $\frac{2}{3}$, not reaching $\frac{1}{3}$ across wing, costal marks

tinged ochreous on posterior half; dorsal area obscurely streaked white transversely, these streaks more or less confluent beneath fold, a rather oblique dark fuscous streak from middle of dorsum crossing $\frac{2}{3}$ of wing; ocellus limited by leaden-metallic lateral streaks, internally tinged yellowish and containing three short fine blackish dashes, termen beyond this ochreous with two or three blackish dots before margin: cilia grey with black basal line (imperfect). Hind-wings dark fuscous; cilia grey, a dark fuscous basal shade.

1 ex., Curepipe.

GELECHIIDAE.

Sitotroga cerealella, Ol. Encycl. Méth. Ent. 1: 121 (1789).

Nearly cosmopolitan, introduced with grain.

Dichomeris ianthes, Meyr. Trans. Ent. Soc. Lond. 1887: 273.

Also from Seychelles, North-East Africa, and Indo-Malayan region. Larva on *Medicago* and other Leguminosae.

Brachmia convolvuli, Wals. Proc. Zool. Soc. Lond. 1907: 944, pl. li, 16 (1907).

Comoro Islands, South Africa, Canaries, Indo-Malayan region. Larva on species of *Ipomoea*, especially the sweet potato.

METACHANDIDAE.

Taragmarcha filicineta, sp. n.

♀. 9 mm. Head grey. Palpi white, second joint grey except tip, terminal joint with a basal ring and anterior edge except near base dark fuscous. Thorax grey, tegulae bronzy. Fore-wings rather elongate, costa gently arched, apex rather produced, acute, termen very obliquely rounded; brownish-bronze; white transverse lines at about $\frac{1}{3}$ and $\frac{2}{3}$, second slightly irregular; apical area beyond second suffused dark grey, two or three dots of whitish suffusion towards apex: cilia light grey somewhat mixed whitish. Hind-wings grey; cilia light grey.

1 ex., Mt. Corps-de-Garde, November.

Taragmarcha laqueata, Meyr. Trans. Ent. Soc. Lond. 1910: 370.

Endemic.

Taragmarcha glutinata, sp. n.

♀. 23 mm. Head light grey, sidetufts and face whitish. Palpi whitish, second joint with a slender dark fuscous longitudinal streak towards base and apex only, terminal joint dark fuscous anteriorly except at base. Thorax light grey. Fore-wings elongate, costa slightly arched, apex obtuse, termen very obliquely rounded; whitish, dorsal $\frac{2}{3}$ suffused light grey from base to end of cell, beyond this interneural streaks of light grey suffusion not reaching a curved submarginal series of pale interneural spots from costa near apex to tornus; a dark grey dot towards costa before middle, and one on end of cell (second discal stigma); a fine grey line beneath costal cilia from middle to $\frac{4}{5}$, thickened about $\frac{2}{3}$; a marginal series of light grey marks round apex and termen: cilia whitish. Hind-wings grey; cilia pale greyish.

1 ex., Curepipe, September; "trunk of *Telfairia*," perhaps bred; it is likely that the species of this family in the larval stage feed on dead wood and bark.

Tanychastis lysigama, Meyr. Trans. Ent. Soc. Lond. 1910: 371.

Endemic.

OXYCRATES, gen. nov.

Head with appressed scales; ocelli posterior; tongue developed. Antennae nearly 1, ♂ shortly ciliated, scape elongate, without pecten. Labial palpi long, recurved, slender, smooth, terminal joint rather shorter than second, acute. Maxillary palpi rudimentary. Posterior tibiae rough-haired above. Fore-wings 2 from towards angle, 3 absent, 6 nearly approximated to 8, 7 absent, 11 from beyond middle. Hind-wings $\frac{3}{2}$, lanceolate, cilia 3; 3 and 4 connate, 5 approximated (?), 6 absent.

Differs from *Metachanda* by absence of vein 3 of fore-wings, from *Stereoptila* by absence of tufts, recognisable from both by very acute fore-wings.

Oxycrates xanthopeda, sp. n.

♂. 9 mm. Head light yellowish, face, palpi, and antennae ochreous-grey-whitish. Thorax light greyish-ochreous. Fore-wings elongate, widest towards base, costa slightly arched, apex produced, very acute, termen slightly sinuate, extremely oblique; ochreous-orange; markings grey edged dark fuscous; costal edge dark fuscous from base to middle; a subquadrate blotch on costa near base, almost or quite confluent with a blotch along basal fourth of dorsum; an irregular antemedian fascia, dilated and furcate towards dorsum; a dark fuscous subcostal line from middle to $\frac{4}{5}$, posteriorly confluent with an S-shaped transverse spot nearly reaching tornus, its upper portion thickened: cilia light greyish, on costa light orange (injured). Hind-wings dark grey; cilia grey.

1 ex., Mt. Corps-de-Garde, November. In imperfect condition, but a very distinct form.

Metachanda larochoa, sp. n.

♂. 13 mm. Head, thorax light grey. Fore-wings elongate, costa gently arched, apex obtuse, termen rather obliquely rounded; light grey, with faint violet gloss; a narrow suffused white costal streak from before middle to near apex; discal stigmata very minute, black; some darker violet-grey suffusion beneath costal streak, a cloudy violet-grey bar beyond cell, and transverse subterminal shade: cilia whitish, tinged grey on tornus. Hind-wings blackish-grey; cilia light grey.

1 ex. Very distinct.

Metachanda brachychlaena, n. sp.

♂. 10-11 mm. Head purplish-grey, sidetufts and face ochreous-white. Palpi whitish sprinkled dark grey, subapical ring of second joint, and base and subapical ring of terminal joint blackish. Thorax dark purplish-grey. Fore-wings elongate, slightly dilated, costa gently arched, apex obtuse, termen very obliquely rounded; ochreous-whitish or whitish-ochreous; basal area to near middle of wing purple-grey irrorated dark fuscous, edge direct, bisinuate, suffused dark fuscous, within this near base a narrow irregular fascia of ground-colour, in one example reduced to two spots; a semi-oval purple-grey spot on costa about $\frac{2}{3}$; some slight greyish-rosy suffusion in disc beneath this, and some towards upper part of termen; in one example a small spot of grey suffusion on dorsum at $\frac{3}{4}$: cilia purplish-grey, basal half spotted whitish. Hind-wings grey; cilia light grey.

2 ex., Curepipe, November; "écorces sèches," apparently bred.

***Metachanda oxyphrontis*, sp. n.**

♂. 11 mm. Head, palpi, thorax whitish, shoulders grey. Fore-wings elongate, costa gently arched, apex obtuse, termen very obliquely rounded; grey irrorated fuscous; dorsal area to fold whitish-ochreous, forming a broad pointed streak, dorsum narrowly grey towards base; stigmata small, black, plical obliquely before first discal, lying in edge of dorsal streak: cilia grey-whitish. Hind-wings grey; cilia light grey.

2 ex., Bellevue Mapou, and Le Chaland, September.

***Metachanda astrapias*, Meyr.** Trans. Ent. Soc. Lond. 1887: 278.

Endemic.

***Metachanda drypsolitha*, sp. n.**

♀. 13-15 mm. Head, thorax light grey, somewhat mixed whitish, face and sides of crown whitish. Palpi grey, extreme tip of second joint whitish, terminal joint whitish posteriorly. Fore-wings elongate, slightly dilated, costa gently arched, apex obtuse, termen very obliquely rounded; grey or brownish-grey, slightly mixed or sprinkled whitish, sometimes irregularly sprinkled dark grey; stigmata forming small cloudy irregular dark fuscous spots, plical somewhat obliquely before first discal, sometimes edged whitish posteriorly, similar indistinct spots on dorsum before second discal and on costa beyond it, these sometimes united with it in a curved streak of undefined darker suffusion: cilia light grey. Hind-wings and cilia light grey.

3 ex., Le Chaland and Cap Malheureux, September, November.

***Metachanda baryscias*, sp. n.**

♂♀. 12 mm. Head, thorax grey. Palpi grey-whitish irrorated grey. Fore-wings elongate, costa gently arched, apex obtuse, termen very obliquely rounded; grey, some scattered dark fuscous scales; blotches of dark fuscous suffusion on costa near base, at $\frac{1}{3}$, and $\frac{2}{3}$; stigmata forming irregular or roundish dark fuscous spots, plical rather obliquely before first discal, first discal just beyond apex of second costal blotch, second forming a pale-centred ring, surrounded by suffusion confluent with third costal blotch, or wholly merged in dark suffusion; a suffused dark spot on tornus; some irregular irroration towards apex: cilia light grey. Hind-wings rather dark grey; cilia grey.

3 ex., Curepipe and Cap Malheureux, September, December.

***Metachanda holombra*, sp. n.**

♂♀. 11-13 mm. Head, thorax fuscous, face paler, suffused whitish beneath. Palpi fuscous, extreme tip of second joint whitish, terminal joint posteriorly whitish. Fore-wings elongate, costa slightly arched, apex obtuse, termen very obliquely rounded; fuscous, without markings: cilia grey. Hind-wings and cilia light grey.

5 ex., Le Chaland and Curepipe, September, November.

***Metachanda taphrospila*, sp. n.**

♂. 13 mm. Head whitish-grey-ochreous, face whitish. (Palpi missing.) Thorax whitish-ochreous, shoulders dark fuscous. Fore-wings elongate, costa gently arched, apex obtuse-pointed, termen obliquely rounded; pale ochreous, partially tinged brownish; markings blackish-fuscous, partially edged white suffusion in disc; an oblique spot on base of costa; a streak along fold from base to plical stigma; spots representing stigmata, first discal oval, plical smaller, obliquely before it, second discal a slightly curved bar, a small

spot above anterior end of first discal, and a linear mark above and before this; some brown suffusion beneath discal stigmata extending to tornus; a brown quadrate spot on costa at $\frac{2}{3}$; a small spot in disc towards apex; two or three dots on costa towards apex, and a connected line of terminal dots: cilia ochreous-whitish, traces of brownish bars. Hind-wings grey; cilia light-greyish-ochreous.

1 ex. Allied to *fimbriata*.

***Metachanda fimbriata*, Meyr.** Trans. Ent. Soc. Lond. 1910: 369.

Endemic.

***Metachanda trisemanta*, sp. n.**

♂♀. 13–14 mm. Head, thorax pale ochreous with whitish reflections. Palpi pale ochreous, second joint slightly speckled dark grey. Fore-wings elongate, slightly dilated, costa gently arched, apex obtuse, termen rather obliquely rounded; pale yellow-ochreous sprinkled grey and light grey; three dark fuscous subtriangular costal blotches, their margins suffused yellow-ochreous, first near base, small, second before middle, nearly reaching first discal stigma, third at $\frac{2}{3}$, larger, inwards-oblique, reaching second discal stigma; stigmata small, dark fuscous, surrounded by yellow-ochreous suffusion, plical beneath first discal, an additional dot beneath second discal, which is absorbed in costal blotch; an angulated yellow-ochreous line from middle of posterior edge of third costal blotch to tornus: cilia whitish-ochreous, an antemedian series of spots and postmedian line light grey. Hind-wings grey, paler anteriorly; cilia light grey.

2 ex., Curepipe, September, October.

***Metachanda eophaea*, sp. n.**

♂, 10–12 mm. Head, thorax ochreous-grey-whitish sprinkled light grey. Palpi grey-whitish, second joint with three dark grey rings, base of terminal joint grey, in one example palpi wholly suffused dark grey irroration. Fore-wings elongate, costa gently arched, apex obtuse, termen obliquely rounded; grey, tips of scales whitish, with faint pink tinge; small dark fuscous spots on costa near base, and at $\frac{1}{3}$ and $\frac{2}{3}$, first in one example prolonged as a bar half across wing; stigmata small, dark fuscous, plical somewhat before first discal, an additional dot near beneath second discal, two others above and below middle of disc, and one beyond and above second discal; small dark fuscous spots on dorsum at middle and $\frac{3}{4}$ and on tornus, and one towards termen in middle: cilia light grey. Hind-wings and cilia grey; some long fine scattered projecting hairs along anterior part of costa.

2 ex., Curepipe, November.

***Metachanda gymnosopha*, sp. n.**

♂♀. 13–15 mm. Head, thorax whitish-grey. Palpi grey-whitish, second joint in one example with basal $\frac{2}{3}$ and a subapical ring grey. Fore-wings elongate, slightly dilated, costa slightly arched, apex obtuse, termen rather obliquely rounded; whitish-ochreous-grey, some scattered dark grey specks; in one example small blackish spots on costa at and near base, these quite obsolete in the others; stigmata small, blackish-grey, plical somewhat beyond first discal, an additional dot near beneath second discal; a small fuscous spot on costa at $\frac{2}{3}$; two or three dark grey dots in disc towards termen; a marginal series of dark grey dots round apical part of costa and termen: cilia grey-whitish. Hind-wings and cilia light grey.

3 ex., Bellevue Mapou and Le Chaland, September, October.

***Metachanda ptilodoxa*, sp. n.**

♂♀. 13-14 mm. Head, thorax grey-whitish, with faint greenish tinge, anterior half of thorax sometimes light brownish. Palpi whitish, basal half and subapical band of second joint, and basal and broader subapical band of terminal joint blackish-grey. Fore-wings moderate, costa gently arched, apex obtuse, termen rather obliquely rounded; grey-whitish, with faint greenish tinge, irregularly sprinkled dark fuscous; a light brownish blotch mixed blackish occupying basal fourth of costa and reaching half across wing, an oblique blackish streak between angle of this and dorsum; an undefined subtriangular patch of light brownish suffusion irregularly mixed blackish extending over costa from about $\frac{1}{3}$ to $\frac{2}{3}$, and reaching to about fold, costal part of this suffused blackish beyond middle of wing; large light brownish tufts on anterior edge of this denoting first discal and plical stigmata, latter slightly posterior, second discal forming a small blackish tuft, an additional one beneath it, a tuft of scales beneath middle of disc; an irregular-edged triangular dark grey blotch occupying termen from apex to tornus, angle in middle, several small tufts on its anterior edge; two or three small blackish spots on costa towards apex, and one before tornus: cilia grey-whitish, basal half spotted dark grey. Hind-wings grey; cilia pale greyish, a darker subbasal shade.

3 ex., Curepipe and Le Chaland, August-October. The fore-wings in *Metachanda* sometimes but not always show scaletufts; in this species they are unusually developed.

ANCYLOMETIS, Meyr.

The neururation of hind-wings should be stated as follows: ♀ 2 from $\frac{4}{5}$, 3 from angle, 4 absent, 5 approximated, 6 absent; ♂ with swollen ridge beneath cell, 2 connate with 3.

***Ancylometis trigonodes*, Meyr.** Trans. Ent. Soc. Lond. 1887: 277.

Endemic.

***Ancylometis metaerocota*, sp. n.**

♀. 14 mm. Head, thorax yellow-whitish, shoulders blackish. Palpi yellow-whitish, terminal joint with base and a subapical band dark grey. Fore-wings elongate, costa gently arched, apex obtuse-pointed, termen obliquely rounded; yellow-whitish, on posterior half tinged ochreous-yellow on margins and towards markings; a blackish-fuscous basal patch triangularly prominent in middle; a blackish-fuscous fascia from costa before middle, furcate on lower half and forming two suffusedly confluent lighter violet-fuscous blotches on dorsum; an irregular violet-fuscous fascia from $\frac{2}{3}$ of costa to tornus, partially mixed blackish-fuscous and containing a yellowish dot towards costa; some violet-fuscous suffusion towards apex and upper part of termen: cilia ochreous-yellow, base spotted violet-fuscous. Hind-wings grey; cilia ochreous-whitish, tinged grey round apex.

1 ex.

***Ancylometis dilucida*, Meyr.** Trans. Ent. Soc. Lond. 1910: 371.

Endemic.

***Ancylometis phylotypa*, sp. n.**

♂. 18 mm. Head, thorax light greyish-ochreous, shoulders fuscous. Palpi pale greyish-ochreous irregularly sprinkled fuscous, terminal joint as long as second. Fore-wings elongate, posteriorly dilated, costa gently arched, apex obtuse, termen rather obliquely rounded; pale greyish-ochreous sprinkled fuscous; a small fuscous spot on base of costa; towards base an angulated series of four fuscous dots from costa to below fold; stigmata forming small round dark fuscous spots, plical somewhat before first discal, an additional

spot beneath second discal, a dot close before and above first discal; a small dark fuscous spot on costa at $\frac{2}{3}$; a marginal series of indistinct fuscous dots round apex and termen: cilia pale greyish-ochreous, basal half spotted fuscous. Hind-wings light grey, paler and whitish-tinged anteriorly, discal ridge whitish-ochreous; cilia whitish with greyish subbasal shade, on costa grey.

COSMOPTERYGIDAE.

Cosmopteryx daeryodes, Meyr. Trans. Ent. Soc. Lond. 1910: 372.

Endemic.

Cosmopteryx flavofasciata, Woll. Ann. Mag. Nat. Hist. (5) 3: 438 (1879)
(= *crassicervicella*, Chrét. = *mimetis*, Meyr.).

Nearly cosmopolitan in warm regions. Larva on *Cyperus rotundus*.

Pyroderces coriacella, Snell. Tijdschr. v. Ent. 44: 95, pl. vi, 7 (1901).

Also from Africa, Indo-Malayan region, N.E. Australia, N. America. Larva especially in pods of cotton-plant.

OECOPHORIDAE.

Epiphraetis tryphoxantha, sp. n.

♀. 20 mm. Head, palpi, thorax crimson-grey, face tinged whitish. Fore-wings elongate, rather dilated, costa gently arched, apex obtuse, termen nearly straight, somewhat oblique; yellow; costa suffused crimson-grey towards base, then narrowly white to apex; dorsum slenderly crimson-fuscous towards base, remainder occupied by two connected triangular fuscous-crimson blotches not reaching half across wing, first including some whitish suffusion: cilia rosy-whitish. Hind-wings grey-whitish, becoming light grey towards apex; cilia grey-whitish.

1 ex.

Epiphraetis amphitricha, Meyr. Trans. Ent. Soc. Lond. 1910: 373.

Endemic. Five examples in M. Carié's collection.

Cryptolechia thesmophila, sp. n.

♂. 19 mm. Head, thorax ochreous-whitish. Palpi whitish, second joint with scales expanded above towards apex, fuscous except tip. Fore-wings elongate, posteriorly dilated, costa gently arched, apex obtuse, termen obliquely rounded; ochreous-whitish, slightly sprinkled fuscous; stigmata moderate, dark grey, plical rather obliquely beyond first discal; an irregular interrupted transverse shade of grey suffusion about $\frac{4}{5}$, angulated in disc and indented towards costa; a marginal series of dark grey dots round apical part of costa and termen: cilia ochreous-whitish. Hind-wings light grey; cilia whitish.

1 ex., Curepipe, October.

COPROMORPHIDAE.

Copromorpha aeruginea, Meyr. Ann. S. Afr. Mus. 17: 9 (1917).

Also from South Africa and Comoro Islands.

GLYPHIPTERYGIDAE.

Imma infima, sp. n.

♀. 15-20 mm. Head, palpi, thorax fuscous. Fore-wings moderate, posteriorly considerably dilated, costa slightly arched, faintly bent at $\frac{3}{8}$, apex obtuse, termen slightly rounded, nearly vertical; 7 and 8 stalked, 8 to termen; rather dark fuscous; a small obscure dark fuscous dot on end of cell: cilia fuscous. Hind-wings dark grey; cilia grey.

1 ex., Curepipe. Also 1 (the smaller example) from Comoro Islands in my collection. Allied to *quaestoria*, Meyr., from Aldabra.

Simaethis ialeura, Meyr. Exot. Microlep. 1: 46 (1912).

Also from India and Ceylon.

Choreutis bjerkandrella, Thunb. Diss. Ent. Ins. Svecica. i: 24 (1784).

Also from Europe, Asia, N. Africa, Australia, New Zealand.

Glyphipteryx ditiorana, Walk. List spec. Lep. B.M. xxviii: 348 (1863).

Also from South Africa and Indo-Malayan region.

GRACILARIIDAE.

Aerocercops macrochalca, Meyr. Trans. Ent. Soc. Lond. 1910: 373.

Endemic.

Aerocercops triactis, sp. n.

♂♀. 9-10 mm. Head, thorax light grey or whitish-grey. Palpi whitish with undefined grey bands. Fore-wings very narrow, long-pointed, acute; grey, darker-irrorated, becoming dark grey posteriorly; three small blackish tufts on dorsal edge, not projecting; a round black apical dot ringed white except beneath, from which a slender pointed pale yellowish streak extends along termen to tornus, its lower half edged anteriorly by a white strigula, two converging white strigulae from costa near apex running into upper part of streak: cilia grey-whitish, above apex two dark fuscous hooks, from apical dot a rather curved grey antemedian line to tornus, enclosed basal area suffused pale ochreous-yellowish. Hind-wings grey; cilia light grey.

4 ex.

EPRMENIIDAE.●

Idioglossa bigemma, Wals. Trans. Ent. Soc. Lond. 1881: 273, pl. xiii, 42.

Also from South Africa.

PLUTELLIDAE.

Helenodes platyaema, sp. n.

♂♀. 12-13 mm. Head white. Palpi greyish, tip white. Thorax white, tegulae suffusedly sprinkled fuscous. Fore-wings elongate, parallel-sided, costa slightly, towards apex moderately arched, apex obtuse-pointed, termen rather sinuate, somewhat oblique; bronzy-fuscous, more or less transversely strigulated whitish, especially on costal area, dorsal area irregularly suffused whitish; an oblique rhomboidal dark bronzy-fuscous blotch from dorsum beyond middle reaching half across wing: cilia bronzy, on tornus whitish. Hind-wings grey, slightly purplish-tinged; cilia light grey.

2 ex., Curepipe, October. Closely allied and similar to the only other known species of the genus, *murmurata*, Meyr., from Assam, yet differing widely in form of fore-wings, which in *murmurata* have the termen very oblique.

LYONETIIDAE.

Lyonetia carcinota, Meyr. Trans. Ent. Soc. Lond. 1910: 374.

Endemic.

Bedellia autoconis, sp. n.

♂♀. 9–10 mm. Head whitish, a greyish-ochreous or fuscous bar on forehead. Palpi whitish. Antennae above grey with slender whitish rings, beneath grey-whitish with slender grey rings. Thorax pale greyish-ochreous speckled grey. Fore-wings light greyish-ochreous sprinkled dark grey; dorsal area usually paler or whitish-tinged: cilia pale greyish. Hind-wings rather dark grey; cilia light grey.

4 ex. I have also 8 in my collection from Pretoria and Haenertsburg, Transvaal; and Sarnia, Natal. This was formerly recorded by me erroneously as *somnulentella*, Zell., both from Mauritius and South Africa; I had not then learned to discriminate the extremely closely allied species of this genus. The present species can be distinguished from the others by the antennae.

Oinophila siccata, Meyr. Trans. Ent. Soc. Lond. 1910: 375.

Endemic.

Oinophila trixysta, Meyr. Trans. Ent. Soc. Lond. 1910: 376.

Endemic.

Oinophila hydrochalcæ, sp. n.

♂♀. 13–18 mm. Head dull light fulvous. Palpi blackish, tip white. Thorax pale brassy-yellowish, shoulders suffused fuscous. Fore-wings elongate-lanceolate, apex produced, acute; pale shining brassy-yellowish, partially and irregularly mottled and spotted dark bronzy-fuscous; a thick dark bronzy-fuscous streak from near base of costa to fold at $\frac{1}{5}$; a narrow semioval dark fuscous streak along median portion of dorsum, from its middle a thick dark bronzy-fuscous streak runs obliquely to near middle of costa, thence to about tornus, and again to costa at $\frac{2}{5}$: cilia brassy-whitish, a faint grey antemedian line, base sprinkled dark fuscous, above apex a dark fuscous spot. Hind-wings grey; cilia pale greyish.

4 ex.

Oinophila pentacarpa, Meyr. Trans. Ent. Soc. Lond. 1910: 376.

Endemic.

Oinophila crypsirias, sp. n.

♀. 13 mm. Head, palpi, thorax fuscous, face paler, frontal tuft brownish. Fore-wings elongate-lanceolate, apex produced, acute, upturned; rather dark fuscous; undefined spots of paler suffusion in disc at $\frac{1}{3}$ and beyond middle, and on tornus: cilia grey. Hind-wings light grey; cilia pale grey. Fore-wings beneath light grey with strong pearly iridescence.

1 ex.

Oinophila fragosa, Meyr. Trans. Ent. Soc. Lond. 1910: 376.

Endemic.

***Oinophila aethalopis*, sp. n.**

♂. 9 mm. Head dark fuscous, face whitish-fuscous. Palpi fuscous. Antennae dark fuscous (broken). Thorax bronzy-fuscous. Fore-wings lanceolate, apex rather produced, acute; bronzy-fuscous, posteriorly suffused dark fuscous; a narrow whitish fascia, inwards-oblique from costa, at about $\frac{3}{4}$, interrupted in middle: cilia pale greyish, basal third scaled fuscous. Hind-wings and cilia pale greyish.

1 ex., Curepipe, June.

***Oinophila spathistis*, sp. n.**

♀. 12 mm. Head whitish-grey, forehead suffused fuscous. Palpi fuscous, tip whitish. Thorax dark brown. Fore-wings elongate-lanceolate; dark brown; costa suffused dark fuscous, with about 15 irregularly placed somewhat oblique fine whitish strigulae; an outwards-oblique fascia of whitish-yellowish transverse strigulation from dorsum towards base, and another inwards-oblique from dorsum beyond middle converging to meet beneath costa at $\frac{2}{5}$; an elongate pointed-oval rather oblique whitish-yellow blotch in disc about $\frac{3}{8}$, anterior extremity connected with a costal strigula: cilia whitish, on upper part of termen with two dark fuscous lines near base, above apex a dark fuscous straight projection. Hind-wings grey; cilia light grey.

1 ex., August; "on an old trunk of *Telfairia*."

***Oinophila syntricha*, Meyr.** Trans. Ent. Soc. Lond. 1910: 377.

Also from South Africa.

***Opogona omoscopa*, Meyr.** Proc. Linn. Soc. N.S. Wales 17: 567 (1892)
(= *praematura*, Meyr.).

Also from South Africa, Rodriguez, East Australia, Norfolk and Lord Howe Islands, New Zealand.

***Opogona subcervinella*, Walk.** List spec. Lep. B.M. xxviii: 477 (1863).

Also from Rodriguez, Seychelles, Madagascar, St. Helena, Canaries, and Madeira.

***Opogona phaeochalca*, Meyr.** Proc. Zool. Soc. Lond. 1908: 737.

Also from Réunion and South Africa.

***Orthochtha crocinaema*, sp. n.**

♂. 9 mm. Head bronzy-grey, forehead and face silvery-whitish. Palpi white, a grey streak externally. Thorax dark fuscous. Fore-wings narrow, widest at $\frac{1}{3}$, thence narrowed to pointed down-turned apex; brownish irrorated dark fuscous; three very oblique white wedge-shaped streaks from costa not reaching half across wing, edged dark fuscous anteriorly, third from $\frac{3}{4}$ and finely margined to apex, where it meets a very fine white terminal line, triangular apical area within these yellow-ochreous marked with a white discal spot at its base; some irregular whitish marking towards dorsum beyond middle: cilia pale greyish, round apex whitish, strong blackish basal lines towards apex on both margins, and a blackish projecting line at apex. Hind-wings grey; cilia light grey.

1 ex., Mt. Corps-de-Garde, November.

Erechthias zebrina, Butl. Ann. Mag. Nat. Hist. (5) 7: 403 (1881).

Nearly everywhere throughout tropical countries.

TINEIDAE.

Tinea saltatrix, sp. n.

♀. 14 mm. Head dark fuscous, face whitish. (Labial palpi broken.) Thorax dark fuscous, posterior margin and apex of tegulae white. Fore-wings elongate, costa gently arched, apex obtuse-pointed, termen rounded, rather strongly oblique; white, slightly speckled brownish; basal half of costa strigulated dark fuscous; several strigulae connected with a spot of brownish suffusion in disc; disc suffused light yellow-brownish from $\frac{1}{4}$ to $\frac{3}{4}$; a moderate slightly sinuate blackish-fuscous fascia from middle of costa to middle of dorsum; a semioval dark fuscous spot on costa beyond this, and mark on dorsum towards tornus: cilia grey-whitish, with 5 or 6 fuscous lines or series of points. Hind-wings pale greyish-brassy; cilia grey-whitish.

1 ex., Curepipe, October.

Tinea despecta, Meyr. Exot. Microlep. 2: 274 (1919).

Also from Indo-Malayan region, E. Australia, S. America, and Cyprus.

PROTAPHREUTIS, Meyr.

Head shortly rough-scaled or on face appressed; ocelli posterior; tongue absent. Antennae $\frac{3}{4}$, joints closely set, ♂ pubescent, scape moderate, with pecten. Labial palpi long, curved, ascending, second joint with stiff rough projecting scales beneath and some lateral bristles, terminal joint shorter than second, transversely compressed and grooved anteriorly, obtuse. Maxillary palpi moderately long, several-jointed, folded, filiform. Posterior tibiae clothed with long rough hairs above. Fore-wings 1b furcate, 2 from $\frac{5}{8}$, 3 and 4 approximated from angle, 7 and 8 stalked (seldom separate), 7 to costa, 11 from before middle, secondary cell well-defined. Hind-wings 1, elongate-ovate, cilia $\frac{2}{3}$; 2 from $\frac{2}{3}$, 3-7 nearly parallel.

This description is substituted for my previous one, which was partly erroneous, having been made from imperfect material.

Protaphreutis antipyla, sp. n.

♀. 15-17 mm. Head white. Palpi white, second joint fuscous except apex, terminal joint with fuscous subapical band. Thorax white somewhat marked brown or dark fuscous. Fore-wings elongate, costa gently arched, apex obtuse-pointed, termen very obliquely rounded; 7 and 8 short-stalked; white; markings fuscous mixed dark fuscous, or brown, or blackish; some irregular small spots along costa; three very irregular-edged narrow fasciae inwards-oblique from costa, first towards base, sometimes interrupted, second median, sometimes interrupted beneath costa, third at $\frac{2}{3}$, sometimes interrupted near dorsum, sometimes connected with an irregular spot on middle of termen: cilia white, indistinctly barred fuscous or brown. Hind-wings light brassy-grey; cilia grey-whitish.

4 ex., November. Variable both in markings and colouring.

Protaphreutis leucopsamma, sp. n.

♀. 23 mm. Head, thorax white. Palpi white, basal $\frac{2}{3}$ of second joint light greyish externally. Fore-wings elongate, costa gently arched, apex obtuse-pointed, termen very

obliquely rounded; 7 and 8 approximated at base; white; some small grey dots, sometimes with a blackish speck, along costa and round termen, and two towards costa about $\frac{1}{3}$; minute blackish specks suffused grey representing stigmata, plical beneath first discal; a pale greyish elongate spot towards dorsum in middle, and one on dorsum towards tornus: cilia white, traces of faint pale greyish bars. Hind-wings pale brassy-violet-grey; cilia white.

1 ex.

***Protaphreutis brasmatias*, sp. n.**

♂. 13 mm. Head, thorax fuscous sprinkled whitish. Palpi whitish, partially irrorated dark fuscous. Fore-wings elongate, costa gently arched, apex obtuse-pointed, termen obliquely rounded; brownish-ochreous irregularly mixed whitish, a few scattered black scales; anterior half of costa dotted blackish; a blotch of black irroration in disc towards base; an irregular fascia of partially black irroration from beyond middle of costa to middle of dorsum; irregular blackish markings indicating another fascia from $\frac{2}{3}$ of costa to tornus, with a small white spot above tornus; a small blackish apical spot: cilia whitish, several series of dark grey points. Hind-wings pale brassy-grey, darker towards apex; cilia pale greyish.

1 ex., Curepipe, October.

***Protaphreutis acquisitella*, Walk. List spec. Lep. B.M. xxviii: 478 (1863).**

♂♀. 14–20 mm. Fore-wings light grey, often more or less suffused light brownish, more or less strewn small scattered dark fuscous dots or spots, costa and termen more distinctly and numerous spotted; a suffused dark fuscous streak from base above fold to $\frac{1}{3}$, a spot representing plical stigma, and a streak from beyond this to above tornus, thence bent up to costa at $\frac{2}{3}$, more or less variably developed, area between these and costa sometimes infuscated, remainder of wing variably sprinkled or suffused whitish: cilia greyish or whitish speckled fuscous, obscurely barred darker.

7 ex., Curepipe, November.

***Protaphreutis sauroderma*, sp. n.**

♂♀. 16–17 mm. Head, thorax ochreous-whitish more or less irrorated grey, face whitish. Palpi grey-whitish. Fore-wings elongate, costa gently arched, apex obtuse-pointed, termen ♀ very obliquely rounded, ♂ rather less oblique; 7 and 8 stalked; whitish-grey irrorated fuscous, strewn numerous dark fuscous dots or small spots, a series along costa and termen; a cloudy oval dark fuscous spot in middle of disc, one on fold rather before this, and an irregular spot on end of cell, these representing stigmata: cilia grey-whitish irrorated fuscous. Hind-wings light bronzy-grey; cilia whitish-grey.

3 ex., Bellevue, Mapou, October.

***Setomorpha rutella*, Zell. Lep. Micr. Caffrorum, 94 (1852).**

Cosmopolitan in warm regions.

***Narycia cubitalis*, Meyr. Trans. Ent. Soc. Lond. 1910: 377.**

Endemic.

OBSERVATIONS ON THE PREDACIOUS HABITS AND PREY OF *COENOSIA HUMILIS*, MG. (ANTHOMYIIDAE)

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[Read October 1st, 1930.]

Acknowledgments. I wish to take an early opportunity of expressing my very great indebtedness to Professor Poulton, whose kind interest in a random observation led me to collect these records and whose generous and untiring help has made it possible to present them in the form of this paper. The tabulated statement which forms the main part of the paper was kindly drawn up by Professor Poulton himself. It is a great pleasure also to acknowledge the invaluable assistance of the following authorities who have determined the material, a task which must have been rendered difficult in many cases owing to the mangled condition of the insects. Mr. J. E. Collin has determined the three captors and those of the prey to which the initials "J.E.C." are added in the tabulated statement. Mr. F. W. Edwards identified all the rest of the Dipterous prey, Mr. W. E. China the Hemipterous prey, Mr. J. V. Pearman the Psocopterous prey, and Mr. F. Laing the Aphid.

EARLIER RECORDS OF THE PREDACIOUS HABIT IN THE ANTHOMYIIDAE.

The first definite record of the predacious habit among the ANTHOMYIIDAE is that given by Professor Poulton in Part I of his paper on Predaceous Insects and their Prey. The species was *Coenosia (Caricea) tigrina*, a specimen of which was taken with an Empid as prey in 1902. In discussing this record Professor Poulton states that he was informed that the COENOSINAE were known to be predacious, but he emphasises the need for further specially directed observations on the nature of the prey in these predacious ANTHOMYIIDAE. Some later records refer to the genus *Lispa*, species of which have been seen by at least two observers preying on different stages of CULICIDAE. *Lispa sinensis*, Schiner, was seen in hundreds eating mosquito larvae at the surface of stagnant drains near Hong Kong by Dr. J. M. Atkinson (1909), and Dr. Lamborn (1920) has observed an undetermined species of the genus in large numbers attacking adults, larvae and pupae of mosquitoes in Nyasaland. The *Lispa* were seen to thrust their probosces into the thorax of larvae and withdraw them from the water; they also pounced on species of *Culex* just as these were emerging from the pupal case. In the Federated Malay States the same observer (1921) saw a species of *Lispa* "carrying on their useful work" in such numbers that he attributed the entire absence of *Anopheles* larvae from certain pools and ponds partly to their agency.

OBSERVATIONS ON *COENOSIA HUMILIS*.

During the summer of 1926 I was fortunate enough to observe considerable numbers of *Coenosia humilis* in my garden. In June of that year a specimen of this species with what appeared to be prey was, at Professor Newstead's suggestion, sent to Professor Poulton, who replied saying that further observations on the prey of this Anthomyiid would be of interest. From the 28th

Prey of <i>Coenosia</i> (<i>Caricea</i>) <i>humilis</i> , Mg. Prey with asterisked Nos. taken by ♂, others by ♀.	Date and circumstances of capture—the <i>Coenosia</i> and its prey together unless otherwise stated—in the garden of 33 Greenhill Avenue, Calderstones district, Liverpool, 1926.
CECIDOMYIDAE.	
1. Cecidomyid sp.	On leaf Michaelmas Daisy, 8.10 p.m., 31.viii.
2. " " ♂.	" " " " 8.5 p.m., 2.ix.
3. " " ♂.	" " " " 6.35 p.m., 15.ix. Very violent shaking and jerking of collecting box necessary to cause release of prey. Prey reduced to very light condition.
4. " "	On leaf of apple tree, c. 6.30 p.m., 23.ix.
MYCETOPHILIDAE: SCIARINAE.	
5. <i>Sciara</i> sp., ♀.	Placed in collecting box and caught by captor, 6.33 p.m., 29.viii.
6. " " ♀.	Taken on small table in bright sunshine, 4.0 p.m., 5.ix.
7. " " ♀.	17.ix.
8. " " ♀.	Taken on plant, 19.ix.
9. " " ♀.	5.0–6.0 p.m., 2.x.
10. <i>Sciara</i> sp., ? <i>annulata</i> , Mg., ♂.	On Michaelmas Daisy, 8.12 p.m., 31.viii.
11. <i>Sciara quinquelineata</i> , Mcq., ♀.	On leaf of Marguerite or Michaelmas Daisy, 9.30 p.m., 29.vi.
12. " " " ♀.	The <i>Coenosia</i> was apparently holding the small fly and appeared to be applying its proboscis to it. On leaf, 8.0–8.15 p.m., 3.ix.
MYCETOPHILIDAE: MYCETOPHILINAE.	
13. <i>Cordyla</i> sp., ♂.	5.0–6.0 p.m., 2.x.
CHIRONOMIDAE.	
14. <i>Chironomus</i> sp., ♂.	On leaf near top of Michaelmas Daisy, c. 8.0 p.m., 29.viii.
15. <i>Chironomus brevitibialis</i> , Zett., ♂.	On leaf Michaelmas Daisy, c. 7.0 p.m., 10.ix. Thorax of prey observed to be empty after capture and before it was pinned or in any way pierced by A.M.E.
16. <i>Orthocladius</i> sp., ♀.	On plant, after 5.0 p.m., 19.ix.
17. <i>Camptocladius stercorarius</i> , de G., ♂.	Captor taken on plant, prey on grass, 30.viii. The living and normal prey placed in box with the <i>Coenosia</i> and captured by it at 6.46 p.m., released 6.52 p.m. when unable to move and apparently shrivelled.
CERATOPOGONIDAE.	
18. <i>Culicoides obsoletus</i> , Mg. (= <i>varius</i> , Winn.), ♀.	c. 7.30 p.m., 29.viii. The prey was accidentally lost after determination.
PSYCHODIDAE.	
19. <i>Psychoda</i> sp., ♂.	On roseleaf, 8.20 p.m., 28.viii. Prey (accidentally lost after naming) not retained after capture by A.M.E.
20. " " ♀.	On top of Michaelmas Daisy, c. 8.0 p.m., 28.viii. <i>Caricea</i> held prey between anterior legs. Proboscis evidently applied or even inserted for c. 1 min. after capture. Appeared to be sucking.
21. " " ♂.	On leaf c. 4 ft. from ground, 8.0–8.15 p.m., 3.ix.
22. " " ♂.	On leaf, c. 8.0 p.m., 3.ix.
23. " " ♂.	On leaf, c. 7.0 p.m., 9.ix.
24. " " ♂.	On leaf, c. 6.45 p.m., 19.ix.
25. <i>Psychoda alternata</i> , Say, ♀.	On high plant, 3.0 p.m., 23.ix.
EPHYDRIDAE: HYDRELLINAE.	
26. <i>Philhygia vittipennis</i> , Zett., ♂. (J.E.C.)	On rosebud in bright sunshine, 3.10 p.m., 5.ix.
CHLOROPIDAE.	
27. <i>Oscinis frit</i> , L., ♀. (J.E.C.)	On leaf, c. 4 ft. from ground, 6.0 p.m., 9.ix. The <i>Coenosia</i> had to be shaken before releasing prey.
28. " " " ♀. (")	On leaf, c. 3 ft. from ground, 3.40 p.m., 11.ix.

Prey of <i>Coenosia</i> (<i>Caricea</i>) <i>humilis</i> , Mg. Prey with asterisked Nos. taken by ♂, others by ♀.	Date and circumstances of capture—the <i>Coenosia</i> and its prey together unless otherwise stated—in the garden of 33 Greenhill Avenue, Calderstones district, Liverpool, 1926.
AGROMYZIDAE.	
29. <i>Liriomyza flaveola</i> , Fln., ♀. (J.E.C.)	On apple leaf, 7.59 p.m., 30.viii. Prey had probably only just been captured by <i>Coenosia</i> , which was unable to stand in the normal position owing to the thickness of its victim. The prey was released immediately the insects were captured.
30. " " " ♂. (J.E.C.)	On leaf of plant, 8.40 p.m., 3.ix. Process of feeding observed with a lens × 10.
31. " " " ♂. (J.E.C.)	On plant, 6.50 p.m., 19.ix. Process of feeding observed with a lens × 10.
32*. " " " ♂. (J.E.C.)	On plant, after 5.0 p.m., 19.ix.
PHYTOMYZIDAE.	
33*. <i>Phytomyza affinis</i> , Mg., ♂. (J.E.C.)	6.5 p.m., 12.ix. Prey caught when both insects were placed in a glass-bottomed collecting-box.
BORBORIDAE.	
34. <i>Limosina puerula</i> , Rdi., ♀. (J.E.C.)	5.0–6.0 p.m., 2.x.
PHORIDAE.	
35. <i>Phora</i> (<i>Trineura</i>) sp., probably <i>aterrima</i> , F. (J.E.C.)	On leaf, c. 4 ft. from ground, 6.5 p.m., 9.ix. The <i>Coenosia</i> only relinquished prey after shaking.
Homoptera : JASSIDAE.	
36. <i>Typhlocyba ulmi</i> , L., ♂.	Under leaf of Michaelmas Daisy, c. 8.30 p.m., 28.viii. Prey relinquished after capture by A.M.E. Two other Muscids seen preying on this or allied sp. of prey but not captured.
37. " " " ♀.	On petal of tall <i>Helianthus</i> , c. 7.0 p.m., 10.ix.
38*. " " " ♀.	On leaf of tree, 6.45 p.m., 19.ix.
39. <i>Typhlocyba</i> sp., ? <i>rosae</i> , L., ♂.	On leaf, 8.0–8.15 p.m., 3.ix.
40. <i>Typhlocyba rosae</i> , L., ♀.	On plant, 6.30–7.0 p.m., 17.ix.
41. " " " ♀.	On leaf of plant, 6.46 p.m., 19.ix.
Homoptera : APHIDAE.	
42. <i>Aphis avenae</i> , F., a late viviparous ♀.†	4.20 p.m., 19.ix. <i>Coenosia</i> seen to fly from perch and return with prey captured on the wing.
PSOCOPTERA.	
43*. <i>Pterodela</i> , Kolbe (= <i>Lachesilla</i> , Westw.) <i>pedicularia</i> , L., ♂.	On plant, 6.30–7.0 p.m., 17.ix.
44. " " " ♀.	17.ix.
45. " " " ♀.	On plant, 6.30–7.0 p.m., 17.ix.
46. " " " ♂.	On plant, 5.0–6.0 p.m., 18.ix.
47*. " " " ♀.	" " " "
48. " " " ♂.	" " " "
49. " " " ♂.	" " " "
50*. " " " ♂.	" " " "
51. " " " ♀.	6.15 p.m., 19.ix. Captor seen to fly from its perch on plant and take the prey flying 1 ft. distant. It then returned to perch and was seen holding the prey.
52. " " " ♀.	19.ix.

† Mr. F. Laing informs me that this *Aphis* is a very common species which migrates between the apple (and various other species of *Pyrus*) and wheat, oats and grasses generally.

Prey of *Coenosia* (*Caricea*) *tigrina*, F., ♀.

Psychoda alternata, Say, ♀. On top Michaelmas Daisy, 7.45 p.m., 28.viii. Prey relinquished after capture by A.M.E.

Prey of *Tachydromia minuta*, Mg., ♀ (EMPIDAE).

Liriomyza flaveola, Fln., ♂. (J.E.C.) On leaf of apple tree, 6.30 p.m., 15.ix. Prey clasped by first and second pairs of legs, head being attacked when taken. Violent shaking necessary to cause release of prey.

August till the 2nd of October, 1926, about fifty specimens of *C. humilis* and also one specimen of *C. tigrina* and one Empid were taken with prey. The foregoing is a tabulated statement of these records prepared by Professor Poulton. The material has been placed in the Hope Collection, in the Oxford University Museum.

Professor Poulton informs me that the arrangement in Verrall's list of British Diptera with the addition of some groups recognised subsequently, has been adopted in the tabulated statement, in accordance with the advice of Mr. Collin and Mr. Edwards.

As the tabulated statement clearly shows, Diptera form about two-thirds of the captures and are represented by twelve different families. Of the Hemipterous prey on the other hand all but one specimen belong to a single genus of JASSIDAE and only one species of Psocoptera was captured.

As Professor Poulton has pointed out to me, the proportion of ♀ captors is very striking; this is well brought out in the table by the method of indicating ♂ captors with an asterisk. In this connection it is interesting to note that very few ♂♂ of *C. humilis* were seen in the garden at the time the observations were made.

The method of capture was frequently observed, especially in the case of *C. humilis*, and could almost be described as lying in wait for the prey. The Anthomyiids took up a position of vantage, usually at the top of some tall plant such as a Michaelmas Daisy (not yet in bloom), remaining there motionless until an insect flew within about two feet of them. When this happened the fly made a quick dart towards its intended victim and either captured or, as more frequently happened, missed it and returned to the same position on the plant. Flies were seen to use the same perch in this way for at least half an hour in succession. The prey was never seen to be pursued more than a few feet from the perch, usually not more than two or three feet.

At least three unsuccessful flights in succession were seen by watching the same fly continuously, the object in one case being a small dipterous insect that I released near the Anthomyiid. From the number of these unsuccessful attempts it would appear that this species of *Coenosia* is not a very expert hunter, and the small size of most of the prey and the number of very minute insects among them, such as the species of *Psychoda* and *Pterodela pedicularia*, would seem to support this conclusion. Further, many of the small insects which figure largely among the prey are also rather slow and hesitating in flight, an additional reason why they should easily be caught. On the other hand it must be noted that the small PSYCHODIDAE were among the commonest insects seen flying near the tall plants, while on the three days when altogether ten *P. pedicularia* were captured out of a total of twenty, these minute insects were on the wing in the garden in numbers sufficient to be very noticeable. In this connection the following valuable information, quoted from Mr. Pearman's letter of July 28th, 1928, to Professor Poulton, is of great interest :—

"*P. pedicularia* is a common Psocid with at least two broods annually and often appears abundantly in June and (especially) in August–September. It occurs in a variety of sheltered situations,—on stems and foliage of trees and shrubs (particularly evergreen), among perennial herbage and standing grasses, and on fallen dead leaves, in chaff, etc. It readily takes wing, and swarming flights (migratory) are frequent in late summer (cf. Hart, 1880, *Ent. Mon. Mag.*, 71 : 141). At such times it will enter houses and stores where, if the necessary food substances are available, a subsequent brood will develop, but the mature

individuals of this generation always endeavour to get out to the open and are then found swarming on windows (cf. MacLachlan, 1867, *Ent. Mon. Mag.*, 3 : 271). The food consists of pleurococcus, micro-fungi, dead insects, and insects' eggs."

It seems certain that such a swarming flight was taking place in the garden on the days when the Psocid was caught in such numbers by the *Coenosia*.

From the method of capture and from the fact that I never saw an attempt at the seizure of a motionless insect, or in nature of one that was not in flight, it would appear likely that the prey is detected by its movement.

On three occasions the actual capture of the prey in nature was seen, but in one case the captor was not secured; it was apparently a ♀ *C. humilis*. This capture took place a few feet above a tall plant, and a short struggle was seen to occur before the prey, a large Chironomid, was brought to the perch to be consumed. In the other cases (Nos. 42 and 51 in the table) the prey was smaller and the capture was made almost instantaneously. Captures were also made by *C. humilis* placed in small glass-bottomed boxes (about $1\frac{1}{2} \times 1\frac{1}{4}$ "), together with small Diptera. The captors were females on two occasions and a male on the third and, in each case, the small fly was caught in less than ten minutes. In one instance it was clearly seen that the fore-legs of the fly were used in capturing the prey.

The prey was not killed immediately, and not, of course, paralysed. This was clearly shown once when a *C. humilis* with newly caught prey released its victim at the moment they were boxed, and the prey, a species of *Chironomus* (No. 14), was able to walk when released by the captor.

Method of feeding. The process of ingesting the tissues of the prey could be observed in detail, through a lens magnifying 10 diameters, when the Anthomyiids happened to consume their meal near the glass side of a collecting-box. In the case of a fairly substantial fly such as *Liriomyza flaveola* the process took as long as twelve minutes. The prey was held between the captor's fore-legs and its head was forced downwards. The Anthomyiid then inserted its proboscis into the thorax through the neck but outside the oesophagus. By rapid up-and-down movement of its proboscis the captor extracted the tissues from the prey, and, in time, the thorax became so empty that the dark labium could be seen through its walls, and it was noticed that the labella scraped along the inside of the thoracic wall scooping out the remains of the tissues. When the thorax was quite emptied the head was attacked through the occipital foramen, and lastly the abdomen, an incision being made near the base and the proboscis inserted several times until the contents were absorbed. This order of procedure was observed with two specimens of *L. flaveola* (Nos. 30 and 31 in the tabulated statement). When the prey was smaller and more delicate (No. 5), the process was much quicker, only occupying about two minutes and the contents of the thorax and abdomen appeared to be absorbed through the thoracic opening.

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THE BIOLOGY OF THE PETROLEUM FLY (*PSILOPA PETROLII*, COQ.)

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[Read October 1st, 1930.]

PLATES XXVIII, XXIX AND FOUR TEXT-FIGURES.

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1. INTRODUCTION.

THE Petroleum Fly is undoubtedly one of the chief biological curiosities of the world, yet although it has been known to entomologists since 1898 there are many interesting points in its biology still to be cleared up.

The credit for the discovery of this extraordinary insect really belongs to George Compere, who was at the time Horticultural Superintendent of Los Angeles County. The presence of "maggots" in oil pools had been known to petroleum technologists for many years previously (Peckham, 1894), but the knowledge had not reached biologists. After unsuccessful attempts to send living larvae to Dr. Howard in Washington, C. G. Kellog of Los Angeles succeeded in rearing the fly, and the adults were sent to Coquillett, who described them (1899, *Canad. Ent.*, 31: 8) as a new species of the Ephydrid genus *Psilopa*.

In 1899 Dr. Howard published a short article on what was then known of the life-history of the fly, in which he described the mode of respiration by means of the posterior spiracles, which can be projected above the surface of the petroleum at will. Nothing was known as to the food, although Dr. Howard naturally supposed that it consisted of dead organic matter—insects or other organisms caught in the oil. Since the larvae are always found in pools of crude petroleum fully exposed to the air there should be no lack of such food matter.

In 1912 Mr. D. L. Crawford gave an account of the external anatomy of the larva and also described certain points of interest concerning the internal structure. It is consequently unnecessary to repeat these here. He was unable to study the feeding habits in detail, as the work was carried out at

Stanford University, which is outside the area in which the fly is found.* However, he made the observation that the larvae will soon cluster around any pieces of raw meat placed in the oil, and as a result he tends to agree with Dr. Howard as to the source of food, were it not for certain other experiments which he reports in the following words:—

“We encounter a difficulty, however, in this regard, because of certain experiments that have been carried out by Dr. Esterley. The oil, as it comes fresh from the well, may be considered quite free from the organic matter mentioned above. By placing the larvae in such oil and by keeping the oil carefully sterilised and covered it would seem that nothing but the actual components of the oil itself would be available for the nutrition of the larvae therein. Yet young larvae have been so placed and they have pupated and emerged as imagines. From this it appears that they are able to derive nutriment from something besides the foreign organic matter. Other experiments are reported by Dr. Esterley, such as rearing adults from young larvae placed in oil filtered through a Gooch filter, sterilised and carefully covered. This, however, would probably not remove all foreign organic matter, leaving the plant and animal juices which might be in the oil. There is a paraffin base in the natural petroleum, and it is probably this which serves as the food of the larvae, (!) in addition to the foreign matter.

“It is very remarkable that such an organism is able to take into its alimentary canal such a substance as petroleum, and not only survive, but actually derive its nutriment from it. By a remarkable adaptation and physiological changes from the normal the epithelium of the digestive canal is able to extract from the oil that part which is nourishing and reject the poisonous part. This process, no doubt, is assisted by the large size of the epithelial cells and by the large amount of surface obtained by the length of the ventriculus.”

The inference to be made from these experiments, namely that the larvae can derive their energy from the digestion of hydrocarbons, is such an astonishing one that the matter seemed worthy of further investigation. If such is indeed their mode of nutrition then they are unique among living things. That crude oil, a substance usually regarded as a most effective insecticide, should serve merely as a medium for their existence is extraordinary enough. The late Dr. C. O. Esterley in 1913 published a note on the Oil Fly, which consisted mainly of a summary of Crawford's paper. He gives no further details of his experiments than are contained in the paragraphs quoted above. Dr. Crawford tells me that as far as he can remember they were on too small a scale to be at all conclusive and that they were never published. From the correspondence with Mrs. Esterley it appears doubtful whether the notes are any longer in existence.

While working at the Entomological Department of the University of California Citrus Experiment Station at Riverside, California, in 1928-9, the opportunity of obtaining this insect in large numbers presented itself and the experiments here described were undertaken.

It is a pleasure here to acknowledge my indebtedness to Dr. Ralph H. Smith of the Citrus Experiment Station, who readily undertook the troublesome business of running the distillation tests and who supplied me with a variety of oils of known composition with which to experiment. Dr. H. P. Hacker

* Prof. Essig tells me that the insect is now known from the San Francisco Bay region, and that there is a likelihood of its having been transported to that locality through the San Joaquin Valley pipe line from the oil fields in Kern County.

and Dr. R. M. Woodman have both readily given me the benefit of their special knowledge of the physics of spray oils. I am also indebted to Mr. A. B. Standfast of the Dept. of Bacteriology, London School of Hygiene and Tropical Medicine, for examining the sections showing bacterial infection. Mr. E. C. Jaeger of the Biology Dept., Riverside Junior College, was of great assistance in obtaining supplies of well preserved material.

2.

EXPERIMENTS ON NUTRITION.

The larvae were all obtained at Los Nietos on the edge of the Santa Fe Springs Oil Field in Los Angeles County, where they could be found in hundreds in many pools of crude waste oil in the neighbourhood of the wells.

Since the oil is a black treacly substance the larvae immediately beneath the surface are invisible save for the minute projecting spiracles, although their constant movement imparts a shimmering appearance to the surface of the pools. The larvae were brought back to the laboratory in screw-top jars containing very little oil. If too much oil is added many of them get deeply submerged and are unable to regain the surface, with the result that they suffocate in about 15 hours.

The oil used in the experiments was warmed and filtered through fine cloth by means of a vacuum pump. A sample of approximately 370 c.c. of oil taken from a pool in which larvae were plentiful and treated in this way yielded a residue of .02 grams of solid matter consisting of fragments of grass, cast skins of larvae, wings and other remains of insects, etc.

In preliminary experiments ten young larvae were placed in each of a series of covered petri dishes containing a layer of clean silver sand, which had previously been heated to redness for some time, and filtered oil to a depth of about one quarter of an inch.

These experiments yielded rather surprising results in that in several lots one or two larvae, amounting in all to about 4 per cent., came to maturity.

A set of similar experiments was then started using eight different oils varying from a light paraffin distillate of a viscosity 105 containing a high proportion of unsaturated hydrocarbons and giving only 51 per cent. unsulphonable residue to a pure heavy white paraffin with a viscosity of 280 and a sulphonation test of 100 per cent. At first difficulty was experienced in that even the heaviest of these oils was too light to suit the larvae, with the result that they failed to keep their spiracles above the surface. This was overcome to a large extent by using a smaller quantity of oil, although even then they experienced some difficulty in locomotion owing to the low viscosity compared to that of their normal environment, and to the fact that they are adjusted to life in oil of a particular specific gravity. Similar results were obtained from these experiments; a few larvae (6-7 per cent.) reached maturity in oils of widely different composition, but there was no suggestion that any one type of oil was chemically more suitable for the larvae than any other. Impure oils containing a high proportion of unsaturated hydrocarbons did not seem any more favourable for development. When the larvae were in transparent oils as in these experiments the explanation of the results became obvious. It was observed that when a larva was temporarily incapacitated by moulting or from other cause it was liable to be attacked and devoured by its fellows, and thus through this cannibalistic tendency a few were enabled to survive.

In order to test this conclusion further a fresh series was run in which 180

larvae, divided into lots of 10, were kept in filtered crude oil from the pools, some of the lots being fed at intervals with small pieces of tuber-moth larvae thrown into the oil; the rest being starved.

The tuber-moth larvae were used as being a close approach to the food supply available under natural conditions. From soon after the commencement of the experiment it could be observed that those without food were less active than those which were supplied with tuber-moth larvae, and at the conclusion of these experiments the following figures were obtained:—

	Pupation.	Adults emerged.
With food	53%	41.4%
Without food	6.3%	1.8%

The possibility of cannibalism was cut out in another experiment in which the larvae were reared singly in tubes containing filtered oil with a small piece of filter paper to provide a place for pupation. These tubes did not provide so suitable an environment for the development of the larvae as did the open petri dishes, and consequently there was a rather higher mortality even among the controls; nevertheless, the results seem sufficiently conclusive:—

	Number of larvae alive after 10 days.	Number of adults emerged.
Larvae in filtered oil without food, 30 tubes	1 Pupa *	1 3%
Larvae in filtered oil with crushed tuber-moth larvae as food, 30 tubes	15 50%	10 33%

* This single survivor was a later-stage larva which had been used accidentally. It pupated two days after the commencement of the experiment, having apparently already consumed sufficient food for the completion of metamorphosis.

In view of these results, and since the details of Esterley's experiments are not available, it seems reasonable to assume that his results, as recorded by Crawford, were due to cannibalism.

The evidence that the larvae cannot subsist on the oil alone is, then, fairly conclusive. The question remains whether they can extract any nutriment from it at all.

Although insects are notorious for the variety of their digestive powers it seems extremely unlikely that they could *utilise* such inactive substances as hydrocarbons. That a small amount of certain non-toxic constituents of the oils might be absorbed and stored (in the fat body or elsewhere) is perhaps not quite so improbable in view of the work of Channon and Collinson (1929), who found that in the rat and the pig a small amount of "mineral" hydrocarbon may be absorbed from the alimentary canal if liquid paraffin is given in the diet for several weeks.

That the very large and conspicuous globules present in the cells of the anterior mesenteron and in the fat body are the result of the ordinary processes of fat digestion and storage and have nothing to do with the absorption of mineral oils is indicated by the fact that they stain readily with Osmic Acid. This substance fails completely to react with pure paraffin or with droplets of crude oil. Sudan III, on the other hand, shows a definite affinity for mineral oils.

The oil in which the insects are found is of course the impure crude residue left after all the more volatile elements have evaporated off. A distillation test of the oil gave the initial boiling point as 275°C. , while at 310°C. only 10 per cent. of the oil had distilled over. This indicates, as was to be expected, that the more volatile elements such as gasoline and petroleum-naphtha are absent. The nitrogen content of the Southern California crude oils, as they come from the wells, is unusually high—upwards of 1.1 per cent. in some instances. An estimation by the Kjeldahl method of the nitrogen content of filtered samples kindly undertaken for me by the Chemical Department of the Citrus Experiment Station gave 0.64 per cent. nitrogen. This nitrogen is generally present in the asphalts and similar compounds, which, being non-volatile, would naturally tend to accumulate in the pools. Since it is now regarded as probable that petroleum is formed from buried organic matter by the action of anaerobic bacteria (e.g. *Micrococcus petrolii*, *Bacillus sulphureus*, Emmons, 1921), which have been shown to be present in the oil-field waters from deep wells (*Science*, Jan. 1, 1926 : 21), it is perhaps conceivable that the larvae might derive a certain amount of food material from some such source.

In this connection it was interesting to find on sectioning that the hind gut contains enormous numbers of bacteria-like bodies. Without fresh material it was unfortunately not possible to identify them with certainty, but stained with Murray's Toluidine Blue—Van Gieson—stain they have the appearance of a Coccobacillus. They are Gram positive, and approximately 1μ in length and are often present also in the mid gut within the peritrophic membrane, although always in much smaller numbers (fig. 9B). What part, if any, these organisms may play in the processes of digestion it is impossible to say.

Certain of the epithelial cells of the mesenteron are seen in section to be distended with spores of a sporozoan parasite, apparently a microsporidian (figs. 9 and 10). The photographs show clearly the swellings produced in the cell and the way in which the nucleus is pushed to one side by the mass of spores. These bodies are approximately 4μ in length and stain very intensely with Toluidine Blue, Haematoxylin and Methyl Blue—Eosin. The multi-nucleate nature of the spore is most clearly seen with the latter stain (fig. 11). Up to the present I have only been able to obtain the one stage of the life-history, so that identification has not yet been possible.

One would have imagined that an animal living in oil would be immune to the attacks of parasites, and it is interesting to find that a Protozoan has been able to follow its host into such an environment.

3. EFFECTS OF VARIOUS OILS.

Since none of the heavy mineral oils appeared to have any toxic effect, the action of the more volatile mineral oils and of various "fatty oils" and "essential oils" was tested. Crawford states that half-and-half mixtures of petroleum with kerosene, xylol, benzine, clove oil, cedar oil, and turpentine have no injurious effects upon the larvae even after four or five days, although any of the last four alone are fatal. I carried out experiments placing larvae in pure samples of (1) Beechwood Creosote, (2) Benzol, (3) Xylol, (4) Turpentine, (5) Clove Oil, (6) Linseed Oil, (7) Pine Oil, (8) Cottonseed Oil, (9) Olive Oil, and (10) Cedarwood Oil. No. 1 was intensely toxic, the larvae going into violent convulsions and dying almost immediately. Both Xylol and Benzol caused death in from 10–15 minutes. No. 4 was fatal in about $1\frac{1}{2}$ hours,

and Nos. 5 and 6 in about 3 hours. Pine Oil and Cottonseed Oil kill in somewhat less than 10 hours, and as one might expect with the heavier "fatty oils," such as 9 and 10, no toxic effect could be observed at all, the larvae being seemingly unaffected after 12 hours.

It seems that these observations may have some interest in connection with the problem of the mode of action of contact insecticides.

Since death by suffocation does not take place under about 12 hours, it is clear that we are dealing with something else than the plugging of the tracheae with oil. It has been shown fairly conclusively by Shafer (1911) and others that the oil sprays act by the condensation of volatile hydrocarbons, which are as a rule highly toxic, inside the tracheae and their subsequent absorption through the thin walls. According to Hacker pure volatile hydrocarbons, when they condense on the tracheal walls, produce a pseudo-anaesthetic effect; true anaesthesia is produced by the absorption of alcohols and other substances which contain active groups, and the absorption of these substances is aided by the film of volatile hydrocarbons already formed on the tracheal lining.

It is of course not surprising that many of the "essential oils" containing, as they do, poisonous and highly volatile substances should prove toxic; what is remarkable is the fact that Xylol, Benzine, Clove Oil, and Turpentine, while rapidly injurious undiluted, should show no toxic effect at all when diluted with equal amounts of petroleum. The probable explanation of this on Hackers theory is that when diluted the vapour at the surface of the fluid is not sufficiently concentrated to produce anaesthesia.

The question next arises—What is the peculiarity of the substance of which the spiracular structures are composed which prevents the spread of the oils into the tracheae. A solid surface having no affinity for oil is very exceptional. It is well known that the heavier oils, if they can reach the tissues of an insect are actually more toxic than the lighter ones. Why do they not clog the protecting bristles and hairs and then spread into the tracheae themselves? The hydrofuge character of the spiracular and other structures of aquatic and other larvae is supposed in many cases to be due to a waxy secretion of the associated glandular cells, although it must be said that the whole subject of differential wetting is as yet very little understood. It may be that there is a watery secretion in the case of the oil fly. It might seem at first sight that this would not suffice, for the work of Hacker has shown that it is only pure hydrocarbons which will not spread on water. In the case of the impure oils, such as those in which the larvae live and in which active groups are certain to be present, the affinity of these groups for water enables the oil to spread. If, however, the aqueous film already contained a sufficiency of active substances, such as NH_2 or other groups, in solution the affinity for the active groups in the impure oil would be satisfied and the oil would no longer spread. In order for such a film to be stable in the presence of an *excess* of oil it would probably be necessary for the external spiracular surfaces to be wetted *preferentially* by the water, otherwise oil would gradually replace it.* Inside the felt chamber, however, the film would probably be stable whatever the affinities of the surface, since any oil which might penetrate into the openings would be present in relatively small quantities. It cannot enter in mass because of the presence of the aqueous film combined with its low surface tension.

* Prof. E. K. Rideal suggests that the non-spreading of the oils over the external hairs might be explained by supposing them to be covered with a strongly hydrophilic "protein" or a much oxidised type of "lipoid."

The same problem crops up in a different way as regards the adult insect, which can walk upon oily surfaces. Other insects are trapped the moment they come into contact with the oil. Although *Psilopa* can walk upon the surface, it is at once ensnared if by chance the oil comes into contact with any part of the body other than the feet. Since an examination of the foot shows no structural peculiarity it must be assumed that the difference between *P. petrolii* and other flies lies rather in the nature of the substance secreted by the glandular hairs.*

The whole subject is highly technical, and one which belongs in the field of the physical chemist rather than the entomologist.

It is characteristic of hydrocarbons that they penetrate living cells very rapidly and are thus highly toxic, and it seems clear from these experiments that the tissues of *Psilopa* are no exception to this general rule; its ability to live in oil depends upon a very efficient protective mechanism. When this protection is overcome, as by immersion in a light petroleum distillate such as gasoline or petrol, the volatile constituents are absorbed and are as quickly fatal as in other animals. Chloroform causes death rapidly, but the larvae will remain active in strong alcoholic picro-formol (Bouins' Fluid) for 20 minutes, which gives some idea of the impermeability of the cuticle.

Since, then, oils seem as toxic to the tissues of this insect as to any other when the protective mechanism of the spiracles is overcome, the difficulty arises—how are the tissues of the alimentary canal able to withstand the oil which is continually swallowed? It appears probable that the answer to this is that the oil never gets into contact with the gut epithelium at all. The fore and hind gut, of course, are protected by a chitinous layer, and in the mid gut there is the peritrophic membrane. The latter is well developed, as is the case with most Dipterous larvae, and from dissections it seems that the oil itself does not actually pass through the peritrophic membrane. The characteristic dark colour is seen only within it, the region between the membrane and the digestive epithelium, as well as the latter itself, being clear and unstained. Moreover the wall of the mesenteron can be dissected away without difficulty, leaving intact the tough peritrophic membrane with its oily contents.

It might be thought that such a thin layer of chitin would not be sufficient to prevent the absorption of toxic hydrocarbons, more especially when one considers how rapidly such substances can be absorbed through the thin tracheal walls when once they enter the spiracles. A possible explanation of this lies in the recent discovery of Campbell (1929) that tracheal structures are not chitinous, whereas the peritrophic membrane most certainly is. The substance of which the tracheae are composed, probably a sclero-protein, has an affinity for and is easily penetrated by oil, as Takatsuki (1917) has shown experimentally; whereas chitin itself, which according to Campbell is a nitrogenous polysaccharide, is much less permeable.

Even if the above is the correct explanation the digestive processes are very far from being understood. There remains the question, how can the digestive enzymes act upon food which is completely immersed in oil? This is all the more difficult to answer in view of the fact that the oil is present in the gut in such enormous quantity relative to the food.

It would seem that the oil must be very thoroughly emulsified before the digestive juices can percolate throughout the gut contents. Even if, as is not improbable, a certain proportion of the work of digestion is carried out by

* It is possibly significant that the female fly is more densely hairy on the ventral surface than the male; a peculiarity perhaps connected with oviposition on oily surfaces.

bacteria in the hind gut the same difficulty arises, for unless the whole is a fine oil in water emulsion it is difficult to conceive how the products of digestion could ever be absorbed.

Here again is an interesting problem for the specialist.

4.

WATER SUPPLY.

Another obstacle that at first sight would seem to confront a larva living in oil would be the water supply. With a few exceptions, such as the larvae of the Leptids, *Vermileo* and *Lampromyia*, which in hot arid countries make sand pits after the manner of ant lions and are consequently exposed to extreme heat and desiccation, Diptera in the developmental stages are confined to damp environments.

It might be expected that this difficulty would be particularly acute in the case of *Psilopa*, a genus the other species of which, as far as is known, have aquatic larvae. A careful examination of the oil pools showed that in many cases the oil overlies shallow puddles of water, and the pools most frequented by larvae are those in which there is no great depth of oil. A series of experiments was conducted with larvae in jars containing crude oil, one set having a small quantity of water added, the others without. There was no difference between the two sets as to the proportion which reached maturity, although it was observed that those with moisture were rather more active and were enabled to crawl round on the glass side of the vessel more easily than those which were dry. Subsequently, when samples of crude oil from Los Nietos were being distilled, it was found that there was a considerable amount of water contained in the oil in the form of minute droplets so that the results of the experiments just described are more easily understood.

5.

TEMPERATURE.

Since summer *shade* temperatures of 100° F. are not uncommon in this region, one would think that insects living in shallow pools of thick black oil fully exposed to the sun must at certain times be subject to conditions comparable to those found in hot springs. The highest temperature which any insect is capable of supporting appears to be about 122° F. (50° C.), which has been recorded for an *Odontomyia* (STRATIOMYIDAE) larva in Golconda Hot Springs near Winnemucca, Nevada (Brues, 1928), but few other hot-spring insects are able to withstand such a high temperature. Nevertheless, the petroleum flies do not seem to aestivate and larvae have been taken from the pools in June, July, and September as well as during all the autumn and winter months.

No doubt the fact that these high temperatures are only maintained for a short while and are nearly always accompanied by clear nights during which radiation proceeds very rapidly, coupled with the ability of the larvae to descend at will below the surface film, explains their ability to continue breeding throughout the year.

6.

HABITS AND LIFE HISTORY.

Under natural conditions the larvae are seen to be constantly in motion as if all the while searching for food. This at once suggests that their food cannot consist solely of the oil in itself, or they would merely absorb it in a leisurely fashion without moving from place to place. It was often observed that they

would cluster around the body of one of the adults, or of some other insect which had been trapped in the fluid. They also frequently leave the pools and crawl around on the oily soil nearby, but they seldom crawl for any distance on a non-oily surface.

On one occasion a number of larvae escaped from a jar containing the natural crude oil, the lid of which had been left unscrewed. During my absence over the week-end fourteen of them had crawled a distance of about three inches across the laboratory bench and into an open petri dish containing an impure light paraffin distillate (viscosity 105 and sulphonation 51), and on my return were found swimming actively about therein. This particular sample of oil had a very strong and unpleasant odour which was apparently attractive to the insects. If they are out of the oil for more than a very few hours they become free from oil and tend to shrivel up and die, apparently from loss of water when no longer protected by a film of oil.

The transference of larvae to a petri dish of refined transparent oil such as medicinal paraffin made it possible to watch their movements with ease under a binocular microscope, since the larvae would soon free themselves, both internally and externally, from the original medium and become transparent. If then a piece of a small caterpillar was thrown into the oil they would quickly cluster around it and could be watched devouring it greedily. If the food was first coloured with some non-toxic stain such as methylene blue, it could easily be seen in the mid gut shortly after the commencement of feeding.

As is easily seen, when the larvae are in a transparent oil, locomotion is effected by an S-shaped undulating movement in the vertical plane, together with peristaltic contractions of the body as in all Dipterous maggots. This is the "swimming" noticeable when just under the surface film of a very viscous oil. They have a very low specific gravity, and when placed in water they float helplessly on the surface. It is obvious that in order to swim in such a viscous medium the muscles must be unusually powerful, and sections show that they are in fact unusually well developed.

When in captivity pupation takes place on the glass sides of the vessel or on the cork, and I was unable to get the insects to pupate in oily sand or soil in cages, although Crawford gives an instance of their doing so. Puparia are difficult to find in the field, but I discovered them occasionally on oily pieces of paper or other rubbish on the edges of the pools. The most usual place seems to be on grass stems, etc., at the margins of the pools, and in two instances larvae ready to pupate were found among oily grass at a distance of 18 inches from the edge of the pool. A sample of soil from the edge of a pool which was swarming with larvae in all stages of development was washed through a fine soil filter with the aid of gasoline, but no puparia were discovered. It does not seem therefore that pupation in the soil is a regular habit.

The adult flies seem to spend all their time in the immediate vicinity of the pools, hiding in the cracks in the soil or walking about with safety on oily surfaces which will entangle any other insect immediately. The tarsi, however, appear to be the only part of the insect to which the oil does not adhere; should they accidentally allow any other part to come into contact with it they are overwhelmed. They thus live a precarious existence and must walk delicately, for a false movement or a sudden puff of wind usually means destruction by their rapacious offspring!

The eggs I was not able to find, although very minute larvae apparently not long hatched were found frequently in the oil. In captivity they have been found on the surface of "oil soaked but dry leaves" (Esterley, 1913).

7.

DISCUSSION.

As far as I have been able to discover the Petroleum Fly has been recorded only from the oil fields of S. California. An explanation for this restricted distribution may perhaps be found in the mode of occurrence of the oil in that district. It is obvious that the evolution of a species involving such a revolutionary change of habit can hardly have taken place since man began to exploit the natural resources of the country; there must have been natural seepages of petroleum on the surface of the ground available throughout a long period. It is most suggestive therefore that not only are there regions in S. California in which the oil-bearing strata (the Fernando Shales) are near the surface and where natural seepages do occur, but there is evidence that such

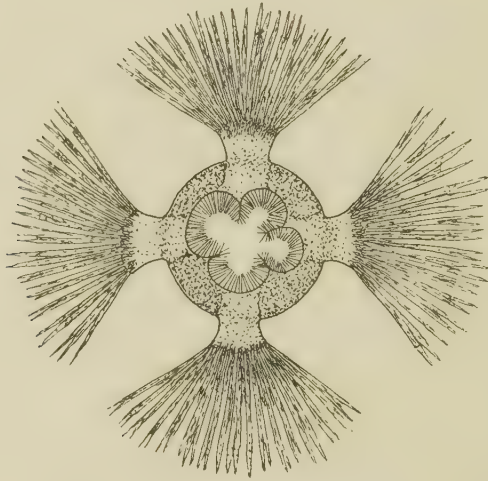


FIG. 1.—*Psilopa petrolii*. Transverse section of posterior spiracle of larva slightly above level of the supporting fans.

conditions have existed for very long periods of time. In the same region, only a few miles from the Santa Fe Springs Oil Field, are the famous asphalt pits of Rancho La Brea, where, by the same process which occurs to-day, the heavy asphaltic oil underwent a process of natural distillation till it was sufficiently tenacious to entrap and hold the largest of the mammals—*Elephas*, *Mastodon*, and the great Sabre-Toothed Tigers—and preserve their remains in extraordinary perfection.

But even though the insect has had a long period of time during which to adapt itself, it almost baffles the imagination to conceive the way in which such a change can have taken place, for there can be no gradual transition between water and oil. If, however, the ancestors had been soil living, then a gradual transition would be more conceivable and the process of adaptation to the new environment easier to understand. But, beyond the fact that the family is almost entirely aquatic in the early stages, too little is known concerning the habits of any closely allied species of this genus to enable us to speculate upon its evolutionary history with any degree of certainty.

It is difficult to suppose that all the modifications necessary to a life in oil

arose together at the crucial moment when the opportunity to invade an oily environment presented itself, and it seems more likely that the supposed aquatic ancestor of *P. petrolii* was pre-adapted to a life in oil, at any rate to some degree, for since we know practically nothing about the life-histories of other species of the genus we cannot say definitely that they are *incapable* of surviving contact with oil or living as larvae therein. All we know is that they do not do so.

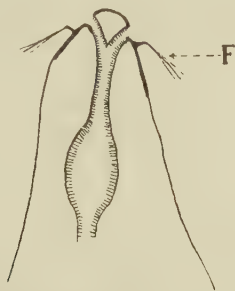


FIG. 2.—*Psilopa petrolii*. Semi-diagrammatic longitudinal section of posterior spiracle of larva passing through two of the spiracular openings. F.—the supporting fans which rest upon the surface of the oil, and thus keep the openings above the surface.

With regard to the fitness of *P. petrolii* for life in this peculiar medium, it seems clear that the adaptations which enable the larva to live in oil are of a physiological rather than a morphological nature. Thus it appears that changes must have taken place in the character of the spiracular structures to enable

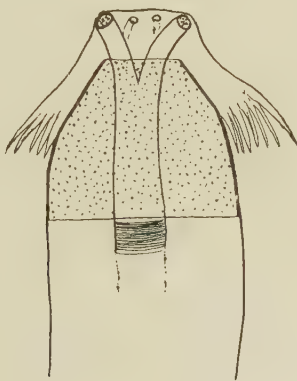


FIG. 3.—Posterior spiracle of larva of *Ephydra riparia* (partly after Trägårdh) to show essential similarity of structure.

them to resist contact with the oil; in the nature of the digestive enzymes; in the secretion produced by the tarsal hairs of the adult, and in the tropisms.

When, on the other hand, we consider structure we find that there are practically no essential differences between *P. petrolii* and a typical aquatic Ephydrid. Thus if any structural adaptation had taken place one might naturally expect it to be in connection with the posterior spiracle, but Fig. 3 shows how essentially similar are the spiracles of *Ephydra riparia* to those of the

oil fly. The well developed felt chamber of the latter is certainly not unique but is found in many other dipterous larvae. Nor is there really any reason for supposing that the large size of the cells of the digestive epithelium or the length of the ventriculus (see Crawford quoted above) has any necessary connection with a life in oil or that it is characteristic of *Psilopa petrolii* as against other closely allied EPHYDRIDÆ. Indeed the only structural modification that can with any degree of certainty be described as an adaptation to this particular environment is the great muscular development by which the larva is enabled to swim through such a viscous medium.*

The floor of the larval pharynx is beset with well-developed longitudinal ridges, Y-shaped in section, which are characteristic of saprophagous Cyclorrhaphous larvae. The buccopharyngeal apparatus is of a simple type compared to that found in *Ephydra*. It consists of pharyngeal, hypostomal, dentate, and paired mandibular sclerites.



FIG. 4.—*Psilopa petrolii*. Mouth parts of mature larva.

It has already been said that the ability to live in oil depends largely on an adequate protection from contact with the medium, such as is given by an impermeable cuticle and peritrophic membrane. But these are not peculiar to the oil fly but are characteristic of the group EPHYDRIDÆ as a whole, and in this respect at least it may be said that the whole group is pre-adapted to a life in oil!

There is no doubt that it is by reason of the characteristic of impermeability that its members have been able to adapt themselves to life in curious and unexpected environments—brackish waters, brine pits, alkaline lakes, waters containing much borax, human urine, the human intestine, tree sap, and so forth. So remarkable is the group in this respect that we might have expected, if life was possible at all in an oil pool, that an Ephydrid would be the first to discover the fact.

8.

SUMMARY.

Psilopa petrolii is an Ephydrid, the larva of which, as has long been known, lives in pools of crude oil in the neighbourhood of the oil fields of Southern California.

* The cuticle, while lacking any definite structural peculiarity, has a curious staining reaction in that the endocuticle refuses to stain with any of the regular chitin stains (Bethe's or Mallory's Connective Tissue Stain), while the exocuticle often stains strongly with haematoxylin and other dyes, a peculiarity for which I am unable to suggest any explanation.

In view of the suggestion that the larva is able to obtain nourishment from the digestion of the crude oil itself, nutritional experiments were undertaken.

It was found that the larvae were unable to live to maturity in filtered oil or in purified paraffin unless they are supplied with animal food such as small insect larvae.

When placed in pure transparent paraffin the method of feeding can be easily observed. They devour quickly any animal matter thrown into the oil, and there is little doubt that under natural conditions small insects trapped in the sticky oil are the chief source of food.

The effect of various oils was tried. The less volatile mineral oils show no toxic effect although if the density is too low the larvae may suffocate through inability to keep the spiracles above the surface. The more volatile mineral oils and "essential oils" are strongly toxic. "Fatty oils" such as cedarwood oil and olive oil showed no toxic effects.

Although oil fills the gut from end to end, it does not appear to pass through the peritrophic membrane and consequently does not come into contact with the mid-gut epithelium itself.

The hind gut contains a Gram positive *Coccobacillus* in great numbers, and the cells of the mesenteron are frequently infested with spores of an unidentified Microsporidian parasite.

The habits and life-history are outlined.

The adaptations which enable the animal to exist in such a strange medium are discussed. They are of a physiological rather than of a morphological nature. Morphologically the larva differs little from many aquatic members of the family. It possesses to an exceptional degree the impermeable cuticle and peritrophic membrane which is typical of the EPHYDRIDAE and which has enabled the group to adapt itself to such varied environments.

9.

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EXPLANATION OF PLATE XXVIII.

FIGS. 5-8. The Habitat of *Psilopa petrolii*. Pools of crude oil at Los Nietos on the edge of the Santa Fe Oil Field, Los Angeles Co., S. California. Photos W. H. T.

EXPLANATION OF PLATE XXIX.

FIG. 9. Transverse section of mid gut of larva of *P. petrolii* showing :—

S.—epithelial cells filled with spores of a microsporidian parasite.

B.—bacteria in the lumen of the gut within the peritrophic membrane.
Haematoxylin.

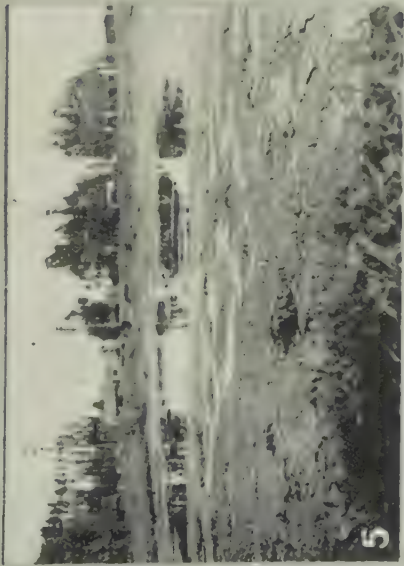
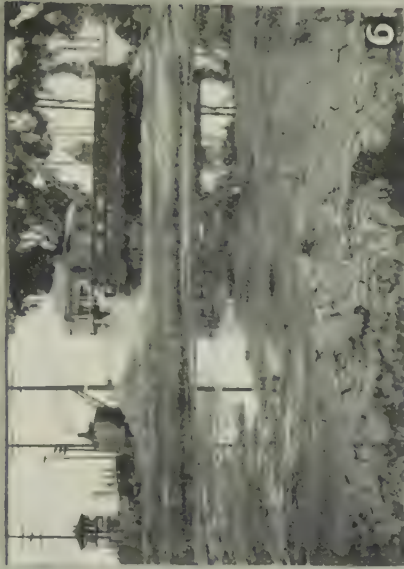
Magnification $\times 1000$. Photo. F. Welch.

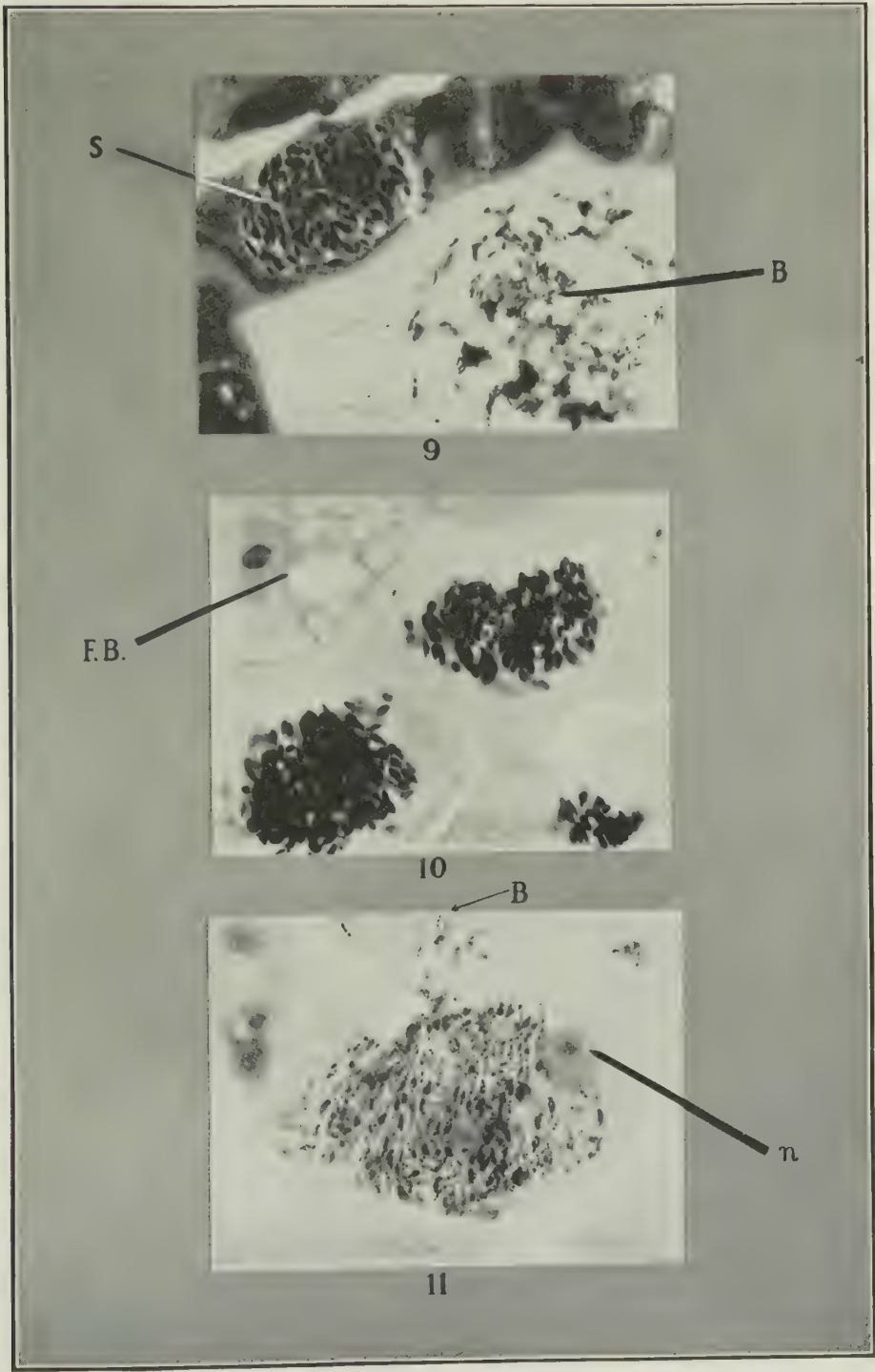
10. Transverse section of mid gut epithelium of larva showing cells filled with spores. Stained Murray's Toluidine Blue. *F.B.*—Fat body with nucleus and large fat droplets.

Magnification $\times 1000$. Photo. F. Welch.

11. Ditto stained Mann's Methyl Blue Eosin. Showing minute nuclei of the spores, and *n.*—the nucleus of the cell pushed to one side by the mass of spores. *B.*—bacteria in the lumen of the gut.

Magnification $\times 1000$. Photo. F. Welch.





FLUCTUATION IN NUMBERS, AND ITS INFLUENCE ON VARIATION,
IN *MELITAEA AURINIA*, ROTT. (LEPIDOPTERA)

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and

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[Read October 1st, 1930.]

PLATE XXX.

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1. PART I. DESCRIPTION OF THE COLONY. (H. D. F.)

(a) *Introduction.*

Melitaea aurinia, Rott., is among the more interesting of the British Rhopalocera, partly because, like some others, it has a double habitat; for while it is essentially a marsh lover, yet its colonies also haunt localities which are quite dry, such as railway embankments and the slopes of hills. But chiefly because, in the first place, it is extremely variable, variation taking place not only among the individuals of a given colony, but also between the forms which are found in different parts of the country, the Welsh, the Cornish, the Irish, the Cumberland and other forms being as a rule recognisably different. Secondly, because colonies of this species have a well-known tendency to die out, or, rather, to dwindle to a few odd individuals for a number of years, and then to reappear again rather suddenly for a considerable period of time. In fact, it has been said that wherever *Melitaea aurinia* has been known to reside, there, sooner or later, it will be found again, unless the terrain has been greatly altered in the meantime.

Within a radius of six or seven miles round Carlisle colonies are to be found in several places; we ourselves know of the existence of six, and in every instance with which we are acquainted the colony is confined to a very restricted area. It is one of these colonies which has formed the main subject of our investigations upon the habits of this species, and we have prepared this paper

in order to give a short account of the disappearance and reappearance of this particular colony, and of its variability.

Our grateful thanks are due to Professor E. B. Poulton, F.R.S., for much valuable help in the preparation of this paper. We are indebted to him for placing the resources of the Hope Department, University of Oxford, at our disposal, and for authorising a grant from the Fund for the Promotion of Research in Organic and Social Evolution, presented to the University by Prof. J. M. Baldwin; to Dr. H. Eltringham, F.R.S., for his great kindness and skill in painting the specimens illustrated on Plate XXX; to Mr. F. H. Day, Carlisle, for much valuable information and for the loan of specimens (Figs. 3, 4, 5); and to Mr. F. Gray, Director of the Museum, Carlisle, for allowing us to make use of the different local collections in that institution.

(b) *Fluctuation in Numbers.*

We have had access to records of the history of this colony which take us back to the year 1881 when it was common, as recorded by Wilkinson (1907). Although confined to the wettest parts of two or three swampy fields, yet by 1894 the species had become so numerous that it attracted the close attention both of local and other collectors. In the March of that year the larvae were recorded as "abundant in broods on webs," in June the imagines were "abundant on the wing," and as late as the 30th of that month they were noticed as "still about."

We find from notes kindly furnished to us by Mr. F. H. Day that in 1895 the larvae were "in swarms," "many pupae on dead oak leaves" (blown into the fields from small adjacent coppices), and that the butterflies were "in countless numbers."

In 1896 it appears to have reached the height of its abundance; "larvae in quantities" are recorded, and it was also noticed that the food-plant, *Scabiosa succisa*, which grows thickly in the locality, had been so defoliated by the swarms of larvae that they were forced to turn to other food, and were found feeding on honeysuckle in the adjacent hedges, a fact worth noting as indicating that this plant is used as an emergency food by this species even when not in confinement.

In this year both the pupae and the imagines were in great abundance. The records speak of "many pupae on dead oak leaves, grass, reed, and bilberry stems," imagines "in clouds" and so on. But from 1897 and onwards, though still common, there was a steady decrease in numbers year after year until 1906, when Wilkinson, *l.c.*, records that he and two other collectors obtained only about a dozen larvae after two hours search. From this time onwards very few butterflies were seen upon the wing, and at last in 1912 the species had practically disappeared, and the first recorded period of this colony's existence was ended.

It is probable that the most important factor in the colony's decline was the rapid growth of parasitism among its members by one of the Braconidae, *Apanteles spurius*, Wesm. The percentage of parasitism seems to have increased with the growth of the colony. In 1894 it is recorded that parasites were "fairly common" among the larvae; in 1895 they were more so; in 1896 "about 75 per cent." of the collected larvae were affected. In the two following years, and possibly even until the end of the colony's career, the percentage became even larger, and we have been informed that sometimes so many as 90 per cent. or even 95 per cent. of the larvae were parasitised. Therefore

parasitism would appear to be a most important, perhaps the most important, factor governing the frequency of the species.

From the year 1912 till 1920 the colony was practically extinct. It was towards the end of this period that we began working the fields which had formed its habitat. Only on two or three occasions did we notice an odd imago, not more than one in any given year, although we were frequently on the fields where once the species swarmed. But in March 1920 we found some sixteen larvae after a very diligent search, and from these we bred out a dozen imagines. The coloration of these specimens was extremely dark, and it is a curious fact that they were all more or less deformed, some hopelessly so; we do not think that either of these peculiarities was due to the manner in which the half-grown larvae were reared, as we have never altered our methods from that time until now; we are rather inclined to attribute them to the rapid increase in numbers of the colony. The more so as malformation, at first a common evil, has become less noticeable year by year, and during the last year or two has practically died out.

In 1921 larvae were more easily obtainable, and the species was fairly common on the wing. From that time onwards, up to 1924, the numbers of the colony increased rapidly. Since that date the species has been common in the locality, with a slow, steady increase year by year, until now there exists a strong well-developed race, differing from the prevalent form of the first period, so that although the butterflies can hardly yet be said to exist "in swarms," as they once did, yet they are quite abundant, and the nests of September 1929 carpeted the ground in many parts of the fields where the colony resides, as did the wandering larvae in April 1930.

Such to-day is the condition of the colony in its second period. A study, therefore, of the frequency of this colony during the last forty-nine years gives a double curve, starting somewhat below its summit in 1881, reaching that summit in 1896, descending steadily during a period of sixteen years, almost to zero in 1912, remaining at that point for eight years till 1920, and rising rapidly from that year onwards to 1924–1925 with a subsequent slow increase up to April 1930.

(c) Variation.

Variation seems to have been uncommon during the period 1894–1912 inclusive, as it probably was during the previous thirteen years, though with regard to them we have not been able to obtain much information. The males of the first period appear on the whole to be somewhat smaller than those of the second, the ground-colour is generally more red, the blotches are reddish or ochreous (Pl. XXX, figs. 1 and 3). The females are larger, often considerably larger than the males, and are generally redder than those found to-day, and, as a rule, the blotches are of a decidedly reddish ochre (Pl. XXX, figs. 2 and 4). On the whole, the insects of the first period are duller and redder than their present descendants, though variation in the direction of paler forms, approximating to those of the second period, are not infrequent, especially among the females. We have had the opportunity of examining specimens of this first period both in public and private collections, and the first impression that one receives, when seeing them in the mass, is that of a duller and darker race than that which is in existence now. Many varieties are to be found in all these collections, and of these the most usual is a small striped form without yellow blotches (Pl. XXX, fig. 5) which has not reappeared since the recrudescence of the colony. But it must be remembered that at the height of its frequency the butterflies

were obtainable in multitudes, and that the aim of most collectors was to capture as many varieties as possible rather than a series of the ordinary form; indeed, we have been told that variation was not markedly frequent, and that varieties were obtained only by capturing and examining large numbers of specimens. This paucity of variation, as will subsequently be seen, is what might be expected in a large, long-established colony, and it is probable that in 1881 the colony of the first period had been in existence for some time. Pl. XXX, fig. 6, illustrates a typical specimen captured in 1905, during the decline of the colony.

When the butterfly first reappeared in 1920, the few specimens which we were able to secure were extraordinarily dark and small. A portrait of one will be seen on Pl. XXX, fig. 9. Its somewhat curious shape is due to the fact that it is slightly deformed. From that date onwards we have obtained a large number of specimens every year, partly from insects caught upon the wing, partly bred from larvae. For the first three or four years the amount of variation was very great; the insects differed widely in size, marking, colour, and in the intensity of their coloration; a small dark male was prevalent at one period while, on the other hand, among the females large, well-marked specimens were not uncommon. The amount of variation during the earlier years of the second period was very great, a few of the forms which we then obtained are illustrated on Plate XXX, figs. 9-14; but, as the colony grew and flourished, these variations were gradually smoothed out and a more or less constant form has been evolved, differing remarkably from that prevalent in the later years of the first period. The males are larger than those of that period, the blotches are straw-coloured and bright in both sexes (Pl. XXX, fig. 7 ♂ and 8 ♀), indeed the insect is quite suggestive of *praeclara*, the Irish form. During the last two or three years, and especially in 1929, it has been difficult to find much variation. In fact, while watching the growth of the colony of the second period, we have been observing the evolution of a constant form, and, to a certain extent, the elimination of variation.

This, it appears to us, is what may be expected in a well-established and isolated colony. It was certainly so in 1894. At that date a tolerably constant form appears to have established itself, differing considerably from that which exists to-day, and variety hunters appear to have had a long and arduous task, in examining large numbers of butterflies in the field.

In another respect, also, the conditions of to-day resemble those of thirty years ago. We have pointed out that parasitism became extraordinarily prevalent as the first colony reached the summit of its career, and appears to have been mainly responsible for its downfall. Parasitism is beginning to set in again; for the first few years of the second period we do not recollect a single parasitised larva; then an odd individual or two was found to be infected; in 1928 a fair number were parasitised, and in 1929 we estimated that the proportion had increased to about 15-20 per cent. of our reared larvae, whether obtained in September 1928 or in March 1929. We are tempted to wonder if the history of the present colony will be that of the former—a rapid growth to large numbers, a period of slower but steady increase, later a great outbreak of parasitism, and in consequence a steady decline.

2.

PART II. DISCUSSION. (E. B. F.)

In the foregoing Sections of this paper some account has been given of an isolated colony of the Butterfly *Melitaea aurinia*, Rott., over a period of forty-nine years. The fluctuations in numbers and variability which occurred during this time are of considerable interest, and merit a short examination.

(a) Fluctuation in Numbers.

It would appear that increase in numbers in this species is partly checked by parasitism, giving rise to cycles of abundance and rarity. There is no evidence that these are synchronous in different colonies over any wide area. Thus the incidence of parasitic infection can scarcely be controlled by general climatic factors, such as those which produce the regular periodicity in numbers demonstrated and studied in so many species by Mr. C. S. Elton (1924, 1925, 1929, and 1927, pp. 127-145). This author, however, points out that "there is no reason why such wave-motions in the population should not be automatic, in so far as each epidemic is followed by a period of recovery which would culminate in another epidemic, and so on indefinitely." In the present example one of the more important controlling factors is parasitism by Braconidae, which gradually increases as the host becomes common, and finally reaches epidemic proportions. The butterflies are then greatly reduced in numbers until chance favourable circumstances once more allow them an opportunity to increase.

The deciding factor may well be a short period of unusually fine weather, even of a few days, at some critical stage in the life-history. Such a crisis as this might occur at pupation, during the final stages of the formation of the imago within the pupa, or at emergence. In this way the numbers might be raised until the natural tendency of the species to increase could once more assert itself. They would then continue to rise, but at a rate depending on weather conditions and other factors, until checked by another epidemic of parasitism.

(b) Variation and Evolution.

It has been pointed out (Fisher, 1922) that the genotypic variability of a species may be regarded as an equilibrium between the action of mutations, tending to increase variability, and of selection, tending to diminish it. From this consideration it follows that, in such an equilibrium, if the mutation rates and the selection rates were always the same, the variance would be proportional to the population.

It is thus apparent that in a given species any lowering of the intensity of selection should result in an increase of variation. But a slackening of selective intensity will in general result in an increase in numbers. This should therefore be accompanied by increased variability, as in the present instance.

Thus it would appear that selection will be less rigorous when a species has been reduced far below its average numbers and is rapidly increasing towards its optimum. At such a time disadvantageous mutations, which represent the majority of all genetic changes, would have a chance of survival. Thus, during periods of rapid increase, accompanied, as has been indicated by increased variation, many of the forms would be of a kind which could not survive with stricter selection, and deformity might be common among them.

Any practically non-adaptive mutations would have an opportunity of spreading through the population in a way which would be impossible if the numbers remained constant. For it has been pointed out by Fisher (1927, p. 276) that the rate at which a gene of non-adaptive significance can spread until it affects say one-third of the genes of a stable population is exceedingly slow, and is comparable to a number of generations of the same order of magnitude as the number of individuals in that population. It is not known how great an increase took place during the five years 1920-1924 inclusive; a general impression leads us to suspect that it must have been at least a thousand-fold. This means that, if the increase were constant, each pair during this period were the parents of four pairs the following year, instead of a single pair as they would have been had the numbers remained steady. But the increase was not constant; it was certainly more rapid during the first two or three years. It is evident therefore that the chance of any non-adaptive or even disadvantageous variations spreading through the colony was increased, though to an unexpected degree. It would, however, have been very greatly accelerated had any variation of adaptive significance appeared. In this way the race as a whole would come to differ from that which formerly occupied the locality.

As soon as the optimum population is reached stricter selection would be established. Undesirable forms of all kinds would be weeded out, with a consequent reduction in the proportion of deformed specimens, while the spread of any non-adaptive variations would also be checked. The species would then settle down to a comparatively uniform type, which, however, would not necessarily be the same as that which obtained before the outburst of variation.

These lines have been followed by the population which we have studied. A rapid increase in numbers associated with increased variability and much deformity; a subsequent reduction in both as the optimum was reached and stricter selection established; and finally the appearance of a comparatively uniform type recognisably different from that which had previously existed.

It is not, of course, suggested that the visible difference between the old and the new forms is of itself adaptive. Any adaptation would probably be in the nature of some physiological change. But genetic factors interact with each other and exert secondary effects. It would seem hardly possible, therefore, for a butterfly to be adjusted to its environment in any particular without influencing in some degree a mechanism so delicately regulated as that which controls the pattern and colour of its wings. For this depends upon the accurate timing of scale development and pigment production (for details of which see Goldschmidt, 1927).

3.

CONCLUSION.

Examples of evolutionary change occurring in nature are of great importance, but they have seldom been observed. We have therefore recorded the foregoing instance, although exact statistical details cannot be supplied. Had we known in advance what would happen, it might have been possible to obtain a fairly trustworthy estimate of the numbers in our colony of *Melitaea aurinia* year by year from 1917 to 1930. It would certainly have been quite easy to estimate the amount of variation each year for one or more characters. But it is our hope that we may have been able to direct the attention of some collectors to this problem. Isolated colonies of this butterfly are not uncommon, and marked fluctuations in numbers have been noticed in them elsewhere. Any one who finds it possible to study such a colony, in which the species is starting to

reappear after a time of great scarcity, would be in a position to conduct an interesting investigation.

The yearly capture of even a hundred insects taken at random, without reference to condition or appearance, should throw much light on the incidence of variation. It should be combined with an attempt to estimate the numbers themselves. This would be less easy, but the numbers captured during a given time in approximately the same conditions at the height of the emergence might be recorded. Or, better, a given number, say 100, could be captured, marked, and allowed to rejoin the colony. The proportion of marked specimens captured in a given time later in the day would give an indication of the total numbers, perhaps of sufficient accuracy for the purpose of estimating relative abundance from year to year. Such a method would be comparatively independent of weather conditions.

4.

SUMMARY.

(1) An isolated colony of the butterfly *Melitaea aurinia*, Rott., has been kept under observation for thirteen years, and its history has been studied for a total period of forty-nine years.

(2) During this time fluctuations in numbers occurred, which were partly controlled by parasitism.

(3) The species was fairly abundant in 1881, exceedingly so from 1894 to 1897. Its numbers then declined until 1906. From this date to 1912 it was uncommon, and from 1912 to 1920 extremely rare. From 1920 to 1924 it increased very rapidly, and since then has remained abundant, with a slow steady increase in numbers.

(4) The amount of variation was small during the first and second periods of abundance, but very great while the numbers were increasing rapidly. At this time varieties in size, shape and colour were extremely common, and a high proportion of them were deformed in various ways.

(5) When rapid increase had ceased these undesirable elements practically disappeared, and the species settled down to a comparatively uniform type which was recognisably distinct from that which prevailed during the first period of abundance.

(6) It is suggested that an evolutionary change has occurred in the colony, and the possible mechanism of this change is discussed.

5.

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EXPLANATION OF PLATE XXX.

Forms of *Melitaea aurinia*, Rott., illustrating evolution in a colony of this butterfly.

All the figures are of the natural size.

- FIG. 1. Male. First period, 1899.
2. Female. First period, 1899.
3. Male. First period, 1897.
4. Female. First period, 1897.
5. Female, 1898. This was the most frequent form of variation between 1894 and 1899. It has not been found subsequently.
6. Female. First period, 1905, during the decline of the colony.
7. Male. Second period, 1929. Normal form.
8. Female. Second period, 1929. Normal form.

Variations during the second period.

- FIG. 9. Female, 1920. Small, dark, and deformed.
10. Female, 1922. Extreme variation; symmetrically deformed.
11. Female, 1922. Almost perfectly expanded.
12. Female, 1922. Deformed.
13. Female, 1922. Deformed.
14. Female, 1926. Extreme variation, which at this date had become very scarce.



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FORMS OF *MELITAEA AURINIA*, ROTT., illustrating evolution
in a colony of this butterfly.

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ERRATA

p. 162, 163, for "*aglaonica*" read "*aglaonice*"
 p. 168, line 43, for "*Eunice*" read "*Eunica*"
 p. 169, line 24, for "*macrula*" read "*maerula*"



